POWER PLANT ENGINEERING

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Isolated Service for Economy

BURROUGHS ADDING MACHINE CO. TO REALIZE MATERIAL SAVINGS BY INSTALLATION OF PRIVATE PLANT; CONDENSING WATER USED FOR HEATING PURPOSES

ONE OF THE LARGEST manufacturing plants in this country devoted exclusively to the building of adding, tabulating and bookkeeping machines is that of the Burroughs Adding Machine Co., of Detroit, Mich.

Since the establishment of this institution, electric current for the operation of the many machines found in this factory and that for the lighting of the grounds, shops and offices has been secured from the distributing lines of the local public utility company, while the heating of the buildings has been by means of a hot water system operated in conjunction with a small plant provided for that purpose. Until recently, and while the output of the Burroughs works was still comparatively small, this arrangement appeared as reliable and, under conditions then existing, as economical as any other. However, as extensions and additions were, from time to time, made and new machinery installed, the light, power and heating loads increased proportionately, and while practically an unlimited supply of electric energy was available, the heating plant soon became too small to meet the requirements placed upon it. Increased capacity was necessary, but before taking any definite step toward the installation of additional heating units, the company's engineering department made a thorough

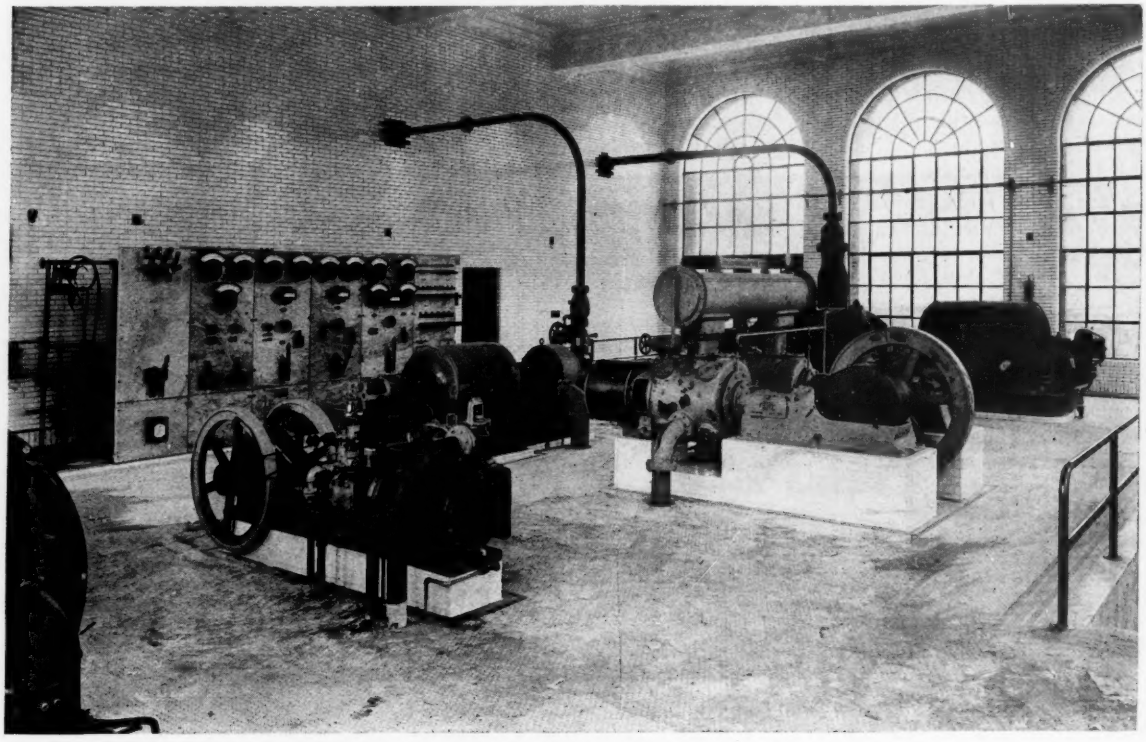

FIG. 1. INTERIOR OF TURBINE ROOM

investigation of the entire situation, and after a careful study of not only present conditions but also possible future power demands, they estimated that a saving of at least $10,000 per year might be realized by the installation of a private power plant and the elimination of the old heating plant and the central station electric service. Accordingly, the Burroughs engineers, in co-operation

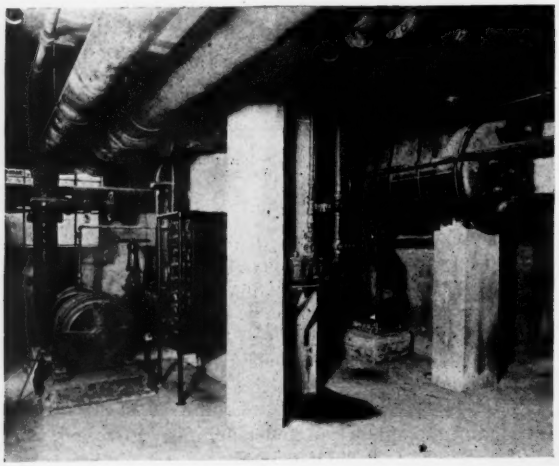

FIG. 2. CONDENSING EQUIPMENT IN TURBINE ROOM BASEMENT

with the architectural firm of Albert Kahn, also of Detroit, began work on the design of a modern isolated power plant to cost no less than $230,000, and while at the time of writing, this plant is still in course of construction, it will undoubtedly be placed in operation some time before mid-summer.

Except for an underground concrete connecting tunnel in which are carried the various air, water, steam and electric lines, the new power house is entirely isolated from the other buildings of the works. It is a substantial single-story, fireproof structure of steel, concrete and brick, occupying a ground space of approximately 75 by 97 ft., and having a height of about 31 ft. from the ground line to the top of the side wall coping, except for the coal tower at the rear of the boiler room, where the maximum height is somewhat greater than 50 ft. A 12-in. transverse concrete party wall separates the turbine room from the boiler room, and in order to provide a basement of sufficient head room below the turbine room for the installation of the condensing equipment, the fire pump and the house service transformers, the floor line of the former is at an elevation of about 12 ft. above that of the latter.

Construction of the building and, as shown in Fig. 4, the general layout of equipment is such as to allow the ready duplication of the plant at any time in the future that this may become necessary.

In the Boiler Room

Coal delivered to the power house is dumped into a 50-ton receiving hopper where it is picked up by an apron conveyor and delivered to a crusher operated by a 35-hp. electric motor, and by means of which it is reduced to a size most suitable for use by the stokers installed. It is then discharged into the buckets of a Stevens-Adamson elevating conveyor, deposited in the 650-ton reinforced concrete bunkers shown in section in Fig. 5 and fed to the furnaces as required by means of a Stevens-Adamson weighing hopper of the traveling type.

The bottom run of the coal conveyor is carried through a sub-basement and is so located with reference to the pits below the furnaces as to allow the ready removal of the ashes and their transfer to a separate receiving hopper on the return trip of the conveyor.

Steam for the operation of the turbines and auxiliary plant equipment is to be generated at a pressure of 200 lb. gage by three 400-hp. McNaull water-tube boilers built by the Union Iron Works, of Erie, Pa., and equipped with Detroit stokers. These, which are arranged as shown in Fig. 4, rest upon concrete foundations with footings extending to a depth of approximately 14 ft. at the front and 6 ft. at the rear, and in order to conform with the interior architecture of the boiler room are encased in settings faced with salt glazed brick of buff color.

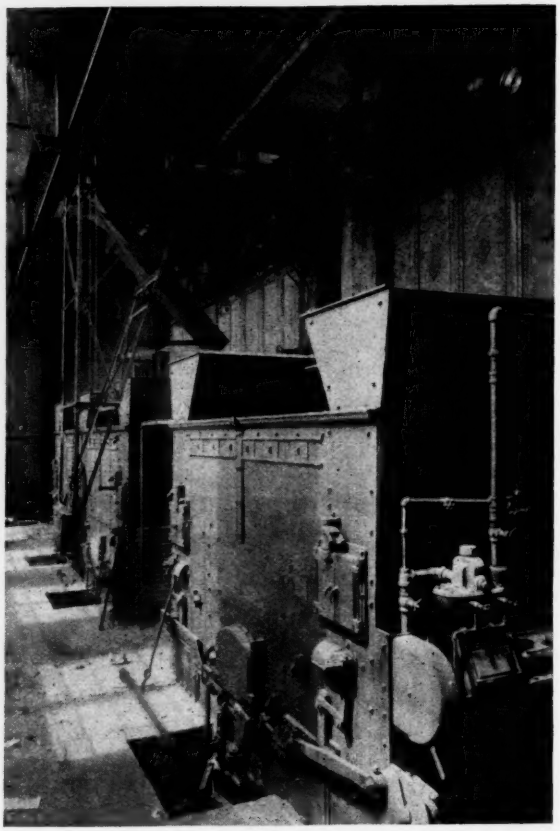

FIG. 3. BOILER ROOM SHOWING FURNACE FRONTS AND COAL WEIGHING APPARATUS

In order to maintain clean heating surfaces, each steam generating unit is equipped with Diamond soot blowers.

Water taken from the city mains is used for makeup purposes, and with the scheme of piping employed, may be fed to the boilers with or without turbine condensate and trap discharges by means of either one of two 12 by 8 by 12-in. National outside center-packed simplex pumps, each equipped with a Copes pump governor; or in the

case of an emergency, by means of a number 15½ O Metropolitan injector. Ordinarily, however, the pumps will be used, and before the water is delivered to the boilers, it will be preheated in an open horizontal feed-water heater of the induction type fitted with a Hoppes V-notch recording meter of 50,000 lb. per hour capacity.

General arrangement of the feed piping is shown in

pumps or through a 2½-in. line to the injector. The latter, in conjunction with another 2-in. line, may also be used for filling the boilers with hot or cold water without in any way interfering with the regular operation of the pumps or the injector, or the boilers in service.

For feeding purposes, the water is delivered to a 4-in. header which discharges into a three-outlet distributing

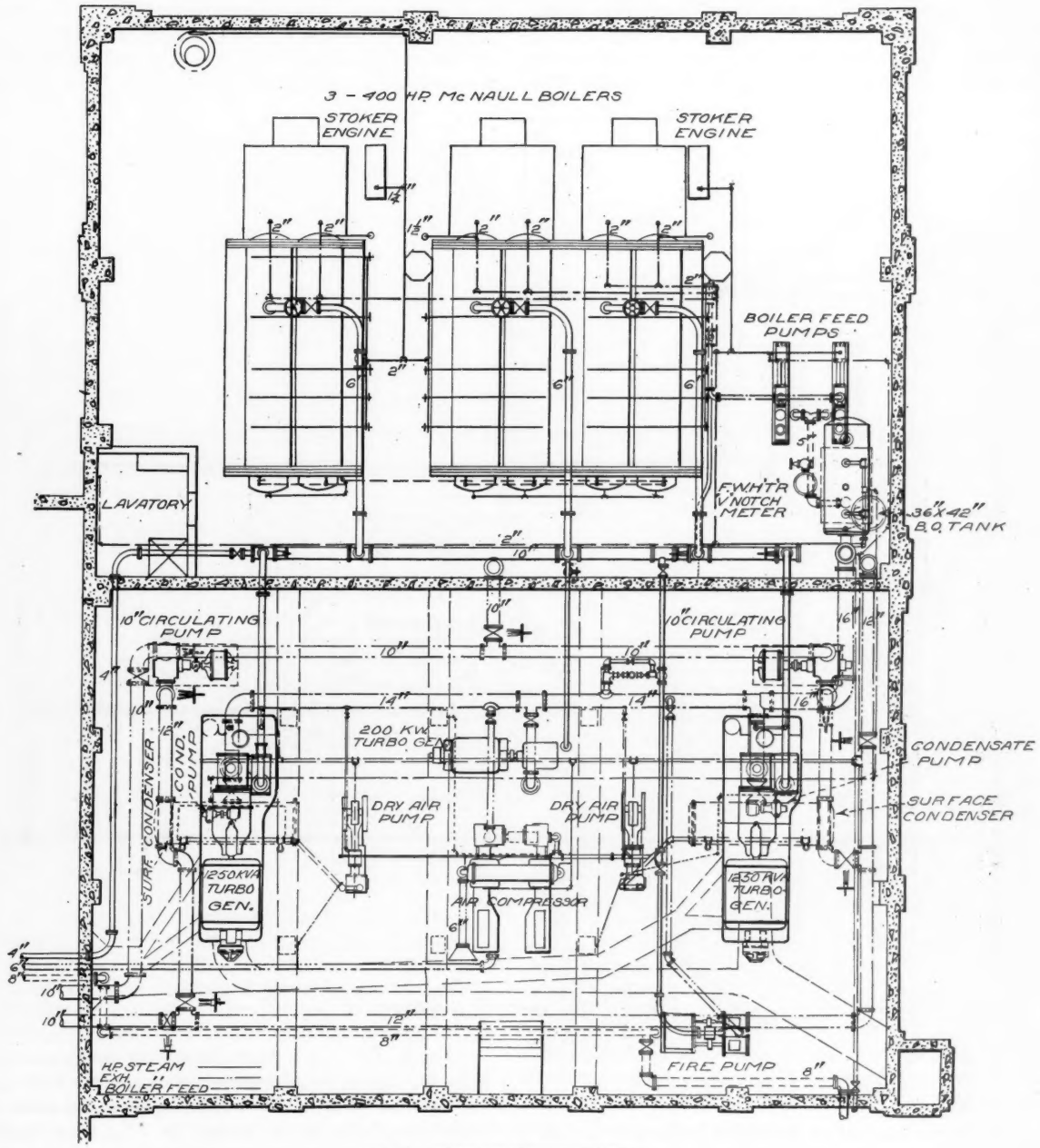

FIG. 4. PLAN OF POWER HOUSE

Figs. 4, 6 and 8. As may be seen by reference to these drawings, makeup and condensate pump discharge lines terminate in a common 2½-in. header connecting with the heater from which, after its temperature has been raised to the desired degree, the water passes through the recording meter and thence through a 5-in. line to the manifold of like size, and which in turn, through the medium of the necessary flow regulating valves, connects with three 2-in. feed lines, one to each of the steam generating units.

The scheme of blowoff piping employed is shown in Fig. 8. Both drums and rear water legs discharge into

a 3-in. header carried below the floor line of the boiler room and connected with a 36 by 42-in. closed blowoff tank provided with a 4-in. atmospheric vent and a suitable outlet to the city sewers.

Turbine Room Equipment

Except for the color scheme used in connection with the various machines, the piping and the switchboard, the interior of the turbine room is finished in white, glazed tiling and marble being employed extensively for the purpose of ornamentation. This not only adds to the beauty and cleanliness of the interior, but together with the large windows in the outside walls, renders possible a most excellent degree of illumination during the hours of daylight.

Artificial illumination is secured by means of lighting units attached to the heavy ceiling beams and side-wall brackets, the general arrangement being as shown in the sectional elevation of the plant, Fig. 5.

Three turbo-generating sets have been installed for the supply of electric current. Two of these, Allis-Chalmers machines, each rated at 1250 kv.a., 2300 v., three-phase, 60 cycles, are for condensing operation, while the other, a unit made up of a Moore turbine direct connected to a 200-kv.a. Allis-Chalmers alternating-current generator with voltage and frequency the same as that of the larger machines, is for noncondensing operation and is for use only during such light load periods as occur on holidays, Sundays and nights. Each unit has its individual exciter direct connected and mounted at the generator end of the set.

In addition to the switchboard, the remaining turbine room equipment consists of two 6 and 14 by 10-in. Alberger dry vacuum pumps for use in conjunction with the turbine condensers, a 30-kw., 110 and 220-v. motor generator set, and a 12-19 by 17-10 by 12-in. Chicago Pneumatic Tool Co.'s steam-driven air compressor provided to supply air at a pressure of about 100 lb. gage for the operation of the various pneumatic tools and devices employed in the shops. A 4 by 12-ft. receiver suspended from the basement ceiling delivers the air to the distributing system.

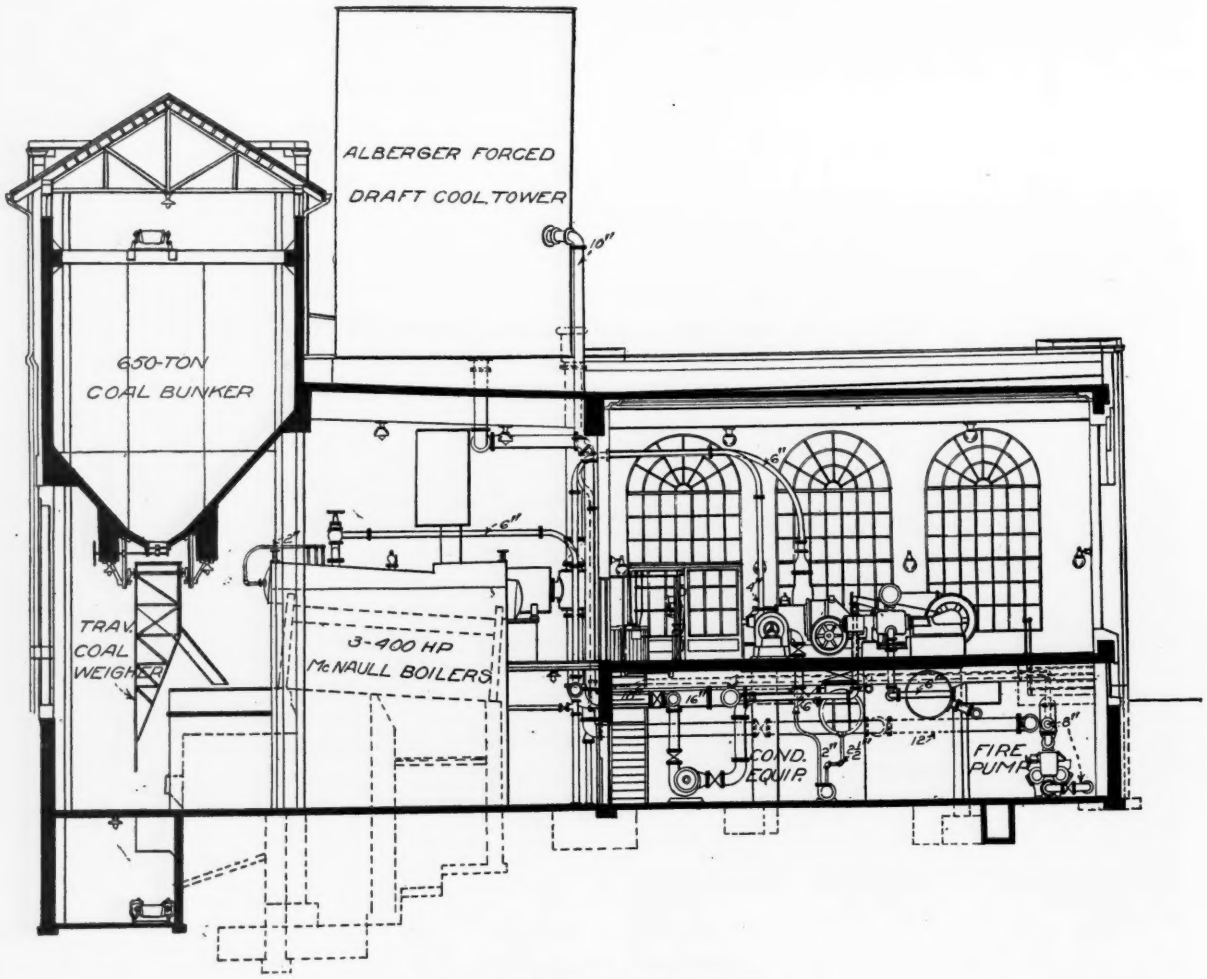

FIG. 5. ELEVATION OF POWER HOUSE

High and Low-Pressure Steam Lines

Leaving the boilers through 6-in. leads, each carrying not only a shutoff valve but also an automatic stop and check valve of like size, steam is delivered to a 10-in. header which, although originally not so designed, has

since its installation been provided with a 4-in. auxiliary line and two gate valves so placed as to divide the header into three sections and to allow the cutting out of service of any one of these three sections without in any way interfering with the regular operation of the plant. All of the distributing leads except a 4-in. line forming an extension to the header and used to serve the works with high-pressure steam, are tied in by means of reducing

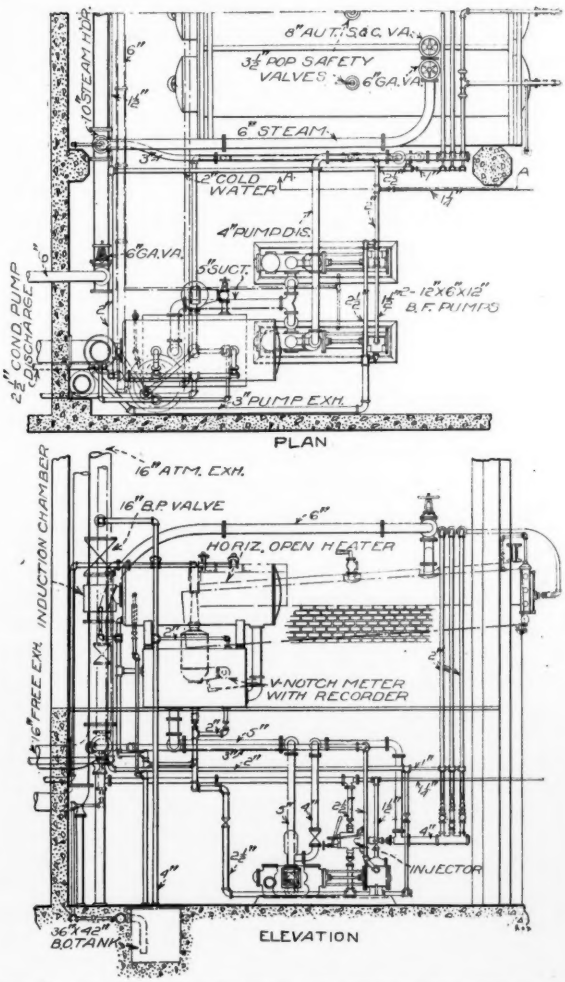

FIG. 6. PLAN AND ELEVATION OF BOILER FEED, PUMPING, HEATING AND WEIGHING EQUIPMENT AND CONNECTIONS

tees; those for the main units are 6 in. in diameter, while for the 200-kw. set a 4-in. branch is used. Another lead consisting of 4 3½ and 1½-in. sections supplies steam to the air compressor, the two dry vacuum pumps, the fire pump, and through the medium of a 1½-in. bypass and a 2½-in. reducing valve, to the 14-in. exhaust line connecting with the feed water heater in the boiler room.

As stated above, all but the 200-kw. set operate condensing. Each unit is equipped with its individual surface condenser, housed within the foundation below and connected to the turbine exhaust by means of a 30-in. corrugated copper expansion joint. The condensers contain 2000 sq. ft. of condensing surface each and are served by 3000-gal.-per-minute Kerr-Kingsford circulating pumps operating at 1150 r.p.m. and direct connected to 50-hp. General Electric induction motors of the variable speed slip-ring type; the condensate as shown in Fig. 5 is removed from the lowest point of the shell through a 2½-in. line connecting with the suction of a 37-gal.-per-minute centrifugal pump, also of Alberger make and direct connected to a 3½-hp. induction motor.

The 14-in. atmospheric condenser exhausts are equipped with Atwood and Morrill relief valves and are tied in with the main exhaust line as shown in Fig. 4, so that should noncondensing operation become necessary or desirable, at any time, the steam exhausted by the turbines may be utilized for the heating of the feed water, or in the event of an excess of exhaust steam, discharged to the atmosphere through the exhaust head attached to the 16-in. line extending to the roof of the boiler room.

Desiring to retain the hot water system of heating and still wishing to eliminate and discard the old heating plant, the engineers employed on the design of this installation decided to utilize the heat contained in the discharged circulating water, and accordingly laid out the piping as shown in the accompanying illustrations. And, although it is expected that with the scheme employed, no difficulty will be experienced in the heating of the works, provision has been made whereby live steam may be injected into the system should the supply of hot water be insufficient or the outside temperature exceedingly low.

Supply and return lines of the heating system are each 10 in. in diameter, and are carried along opposite sides of the turbine room basement where they are con-

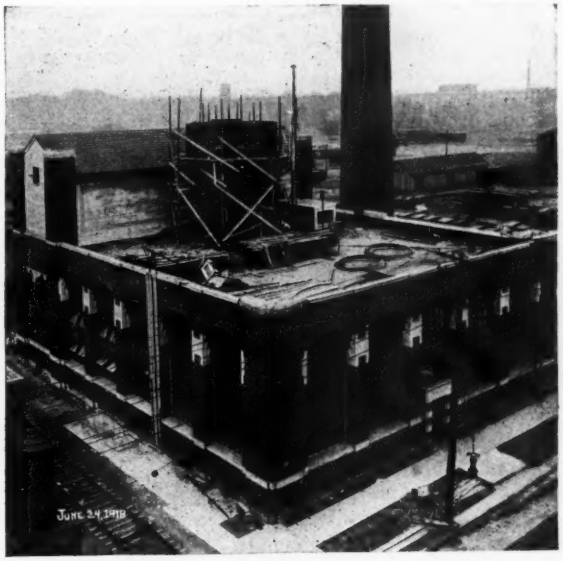

FIG. 7. GENERAL VIEW OF POWER HOUSE

nected to the condensing units in the manner shown in the general plan of the plant. Either one of the units may be operated alone or both simultaneously. The water as it leaves the condensers passes through a 12-in. suction connecting with the circulating pump which discharges it into the 10-in. supply line and, due to the comparatively high head for which it is designed, the pump forces it through the system and back to the condenser, thus maintaining a continuous circulation.

Naturally, during the non-heating months of the year, no need for the circulation of the water through the heating system will exist. By the manipulation of the proper valves, it may then be diverted from its regular course and caused to pass through a 10-in. riser to an Alberger forced-draft cooling tower of cylindrical form having a diameter of 21 ft. and a height of 34 ft., and located on the roof of the boiler room. After passing through this tower and having its temperature reduced to the desired

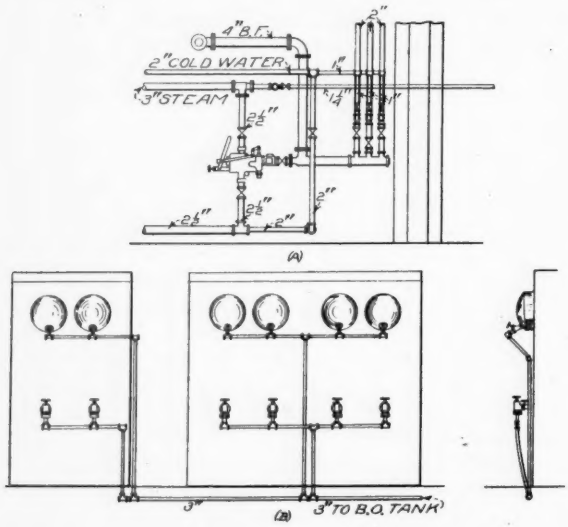

FIG. 8. (A) ARRANGEMENT OF AUXILIARY FEED PIPING (B) SCHEME OF BLOWOFF PIPING EMPLOYED

degree, the water is again returned to the system through a 12-in. drop connecting with the main in the basement of the turbine room.

STEAM FLOW MEASUREMENT

SOME OF THE STEAM generated at this plant will be used for special purposes throughout the works. In order, therefore, to insure proper distribution of operating charges, all steam not used for power generating purposes will be metered by Republic steam flow meters connected to the various supply lines.

ELECTRIC CURRENT DISTRIBUTION

CURRENT is generated at 2300 v. and is delivered to a nine-panel marble switchboard located as shown in the accompanying illustrations near the boiler room wall. Three of the panels of this board are for the control of the main generators, one is for the exciters, one for power house service and the remaining four for works distribution, totalizing instruments and direct and alternating current motor generator set control.

Lines controlled from the house service panel connect with a bank of two 100-kv.a. Western Electric transformers placed directly below the switchboard in the turbine room basement, and are employed for the stepping down of the voltage from that at which the current is generated to 220 v. For the works supply, however, the current is transmitted at 2300 v. by conductors carried through the underground tunnel to a primary switch house at which point it is likewise reduced to 220 v. and distributed throughout the works. A local distribution board carrying one main and eight distribution switches, all of the open knife blade type, has been installed for the purpose.

If so desired, the transformers may be entirely disconnected from the 2300-v. supply lines by means of oil switches mounted on a primary control board, also contained within the switch house.

SPECIAL EQUIPMENT

THE FIRE PUMP referred to above is a 1000-gal.-per-minute Underwriters unit equipped with a Fisher governor and designed to work against a pressure of 100 lb. gage. Ordinarily, this pump, which is supposed to maintain a constant pressure on the fire lines, is depended upon exclusively for protection, but should the pressure on the lines, either with the pump in service or out of service, at any time fall below 45 lb., a reserve supply of water stored in a 60,000-gal. tank will be brought into play, thus insuring at all times adequate protection against a shortage of water.

All work in connection with the design and construction of this plant has been in charge of V. D. Miller, construction engineer of the Burroughs Adding Machine Co.; B. S. Platt is chief operating engineer, and it is through the courtesy and liberal co-operation extended by these two gentlemen that the preparation of this article has become possible.

Broken Crankshafts

CAUSES AND THEIR PREVENTION. BY MAURICE M. CLEMENT

BREAKING of the crankshaft in an engine is a more common occurrence than is generally supposed; it is generally a break that can be repaired only by supplying a new shaft. There is often a great deal of contention on the part of the owner of the engine in trying to establish a flaw in the material whether one really exists or not, and in many of these cases the claims of defect are well founded, when superficial appearances only are considered.

One is not wrong in saying that in 70 per cent of broken cranks, the break shows that at least a portion of the shaft's diameter had been parted for some time. In other words, the separated points indicate an old break for from ½ to ⅔ the diameter of the shaft or less, and only the remainder of the diameter shows a fresh break.

The parts showing an old break often have the appearance of never having been united; with this condition of affairs an owner of a shaft is apparently justified in laying claim to a defect. His claim should receive every consideration that justice and fairness demand, but the real condition that leads up to and causes the break should not be lost sight of. In the majority of cases we feel certain broken shafts are the result of loose journal boxes, as it is not an uncommon thing to see an engine jumping in one or both journal boxes at each impulse the piston receives.

It is a matter that may have been noticed by the operator and regarded as but trivial. Often this loose condition of the boxes entirely escapes the notice of the operator, but it is not a difficult matter to see how loose boxes may result in broken shafts. In the first place, we must consider the heavy flywheels that are carried on the engine shaft; these are quite necessary on a moderate speed gas engine of the single cylinder type, to get the best results in power development, steady speed and fuel consumption and, if properly carried by the shaft, they are really an aid to its long life, rather than a detriment.

Broken crank shafts would, in my opinion, be a very uncommon thing if the journal and wrist boxes were more carefully looked after and kept properly adjusted. The intent of a box or a number of boxes carrying a revolving shaft is to keep the shaft in perfect line at all times; a box cannot accomplish its purpose on a gas engine if it is not carefully and snugly adjusted all of the time, as the sudden force applied to the piston of the engine and through it and the connecting rod to the crank shaft, tends to lift the shaft out of its journal box bed at each impulse, even with the weight of the heavy flywheels crowding it constantly downward into its bed.

If the boxes are snugly fitted, this lifting motion cannot occur, but, on the other hand, if the caps are loose, each impulse raises the shaft and wheels, and as soon as the force of the impulse subsides, the weight of the wheels and shaft bring it down into its bed again with a thump. Now, if only one box is loose and the other one is properly adjusted, the loose end of the shaft only will jump, throwing the shaft out of line at each impulse. This condition may be regarded as even worse than where both boxes are loose; now add to the loose box or boxes the weight of the belt and drive pulley on the shaft and the cause for a great many breaks can easily be explained.

As before intimated, a shaft seldom breaks all at once; the condition that really causes the break has been in existence and started the trouble a long time before the final rupture occurs. There is an unintentional and undue strain on the shaft every time it jumps in the boxes, and this continual heavy strain at regular intervals soon causes what is known as a crystallized condition of the metal in that part of the shaft where the greatest strain occurs.

Crystallizing of the metal destroys the tensile strength of it, and it becomes fragile. Usually this crystallized condition begins at a point on the outer circumference of the shaft and travels towards the center; it does not necessarily affect the entire circumference; a third or half of the circumference only is the rule. At this fragile point, a crack is started by reason of the continued jumping of the shaft in its bearings. As the crystallized condition spreads, the crack grows deeper and deeper until finally the good metal remaining is no longer able to withstand the strain and breaks in two. When the broken ends are examined, the fresh break shows only so far as the good or adhesive metal held on. The original crack may have been started weeks or months before, and the constant motion caused the broken parts to rub together until they often appear as if they had never been united.

Many times the owner of the engine uses the expression "that was never welded properly," or "the shaft was only partly welded." The common opinion or supposition among many engine owners that crank shafts are welded together is ill founded; cranks are generally made by either the drop forging or steel casting process and no welding process whatever enters into their formation. Another process of making crank shafts is cutting them out of solid steel billets.

A peculiar case came under my notice recently. Three shafts in one 25-hp. engine broke within a period of one year and all of them broke at practically the same point. The conclusion was that some unusual condition existed about this engine that was to blame. Upon investigation, it was found that a special length was required in this shaft for the purpose of accommodating an extra heavy and wide belt; an extension shaft was coupled onto the end of the regular shaft, and an outer bearing was supplied for this extension. The outer bearing was found to be out of line with the boxes on the engine base, and in order to run at all with cool boxes the operator concluded he must run with very loose box caps, which he did, with the result already stated.

I never look at a jumping shaft but I feel an immediate desire to get out of the engine room and as far away from the engine as possible until it is shut down and the boxes adjusted, and yet how many an operator will tell you he has operated his engine with loose boxes for a long time? Others are as particular to have the journal boxes of their engines adjusted properly as they are to have a good igniting spark.

Another fruitful source of crank shaft breaking in the gas engine is premature ignition of the charges, which results in pounding in the cylinders. Ignition in these cases comes before the piston has completed its compression stroke and the expansive force resulting from the explosion tends to reverse the piston instantly and drive it backward. The result of this clash of forces is an extra heavy strain on the crank shaft, which, if allowed to continue for any length of time, can only result in serious damage. The crank shaft is an extraordinarily vital part of the engine, as well as a costly one, and it is therefore important that every owner and operator see to it that anything tending to affect adversely smooth running should be promptly remedied. Especially is it necessary to give all reasonable amount of time and attention to seeing that the wrist and journal boxes are in snug adjustment and properly lubricated.

UNTIL SEPT. 15, the Food Administration requests that at hotels and restaurants boiled beef be served only two meals weekly, beefsteak once a week and roast beef once a week. Also it asks householders not to buy more than 1¼ lb. of clear beef per person each week, or 1½ lb., including bone.

The needs of our growing army in France and of our Allies make this course necessary, and it is a part of the service we can do for our boys over there to substitute fresh pork, bacon, ham and sausage for beef products until Sept. 15.

PROTECT your soldiers with your savings.

Power Plant Classification

QUESTIONNAIRE OF THE FUEL ADMINISTRATION ON PLANT EQUIPMENT AND OPERATION. HOW TO FILL IT OUT, AND THE ADMINISTRATION'S REQUIREMENTS. BY A. P. CONNOR, WASHINGTON CORRESPONDENT

IN LINE with its policy to make each pound of coal go as far as possible, the Fuel Administration has in process a plan for inspecting and classifying all power plants by means of a questionnaire which covers equipment and operating methods for both development and use of power. Inspection of plants will also be made to insure the correctness of replies, to suggest improvements and to help in carrying out reforms. On the co-operation given by the plant owner and engineer will depend the fuel supply allowed to the plant.

The first step will be the Questionnaire, with which this article deals. It will be sent to the plant owner by the local Administration; is to be filled out by the owner or engineer and will be verified by the inspector who will call later. After checking up and signing by the inspector, the Questionnaire will be forwarded by the plant management to the State Fuel Administrator, and the plant will be rated and classified by the engineers of the Administration.

The answers should be filled in at the earliest possible moment after the Questionnaire is received, so that the inspector may not be delayed; and we suggest that the answers be prepared in advance of receipt of the government blank by filling in the spaces in the form herewith, which can then be kept for reference.

It should be understood that there is no choice about complying with the administration's requirements as to answering the questions or making changes and improvements. Any attempt to ignore such requirements will be sure to result in severe penalties or possible shutting down of the plant. The Administration is working for the good of the country as a whole, and convenience or preference of individuals cannot be considered, but reasonable requests will be given careful consideration.

FILLING IN THE QUESTIONNAIRE

FILLING in a blank form of any kind always appears intricate at the first glance, and brings up questions as to what should be put down. The questions are also usually written in a manner that does not cover all conditions, and this fact appears to have been appreciated by the Fuel Administration, as it has left space for remarks to bring out special information that a simple answering of the question might not give. The best plan to pursue in answering the Questionnaire is to answer the question as it is put, and then explain in the remarks whatever may be necessary.

The Questionnaire, as it will be provided by the Fuel Administration, is in two parts, one referring to the equipment and its uses in the power plant and the other particularly to the use of fuel and the efficiencies sought in its use. The Fuel Administration makes a list of recommendations in connection with the operation of steam power plants, which should be read before answering the Questionnaire, as it may assist in bringing out the points about which the Administration particularly desires information. These recommendations are as follows:

UNITED STATES FUEL ADMINISTRATION

QUESTIONNAIRE FOR POWER PLANTS

GENERAL INFORMATION

(To be supplied by owner - not to be used for rating of plant)

Date of Report_____

(1) Name of company, concern or owner _____

(2) Address of Central Office _____

(3) Name and location of plant inspected _____

(4) Character of product or service _____

STATIONARY BOILERS

Water Tube Boilers

(5) Number	H.P.	Kind of Draft: Nat'l	Forced	Induced	How Fired: Stoker	Hand	Total Hp.	Remarks

Fire Tube Boilers

(6) Number	H.P.	Kind of Draft: Nat'l	Forced	Induced	How Fired: Stoker	Hand	Total Hp.	Remarks

*MOVABLE BOILERS

(7) Number	H.P.	Type	Remarks

*In the rating of the plant movable boilers will be considered separately. The questionnaire does not call for information regarding movable boilers except as per above table. The influence of movable boilers on the rating of the plant will be left to the judgment of the Administrative Engineer.

(8) Kind of Coal - Bituminous Semi-Bituminous Anthracite

Size

(9) Tons of coal of 2000 pounds used during twelve months ending May 1, 1918? _____

(10) Months of operation of plant during same year _____

(11) Approximately what percentage of live steam is used for:

	Winter	Summer
(a) Making Power	%	%
(b) Heating Building	%	%
(c) Process Work	%	%

(12) Is purchased electric power used? _____

(13) If so, how many kilowatt hours consumed during twelve months ending May 1, 1918? _____

RECORDS

(14) Are records kept to show any of the following information? Answer "yes" or "no" in table below

	By Shift	Daily	Weekly	Monthly
Water evaporated by boilers				
Coal consumed by boilers				
Flue gas analysis				
Electrical output or consumption K.W.H.				

ENGINE EQUIPMENT

STEAM UNITS

(15) ENGINES - TURBINES - PUMPS

Type	No.	Initial Pressure	Rating: H.P.	K.W. or Cal/Min.	Condensing	Non-Condensing	Type of Valve Gear
Simple							
Compound							
Turbine							
Steam Pumps							

(16) What changes have you in progress which are expected to reduce your fuel consumption? _____

(17) When will they be in effect? _____

Further Remarks by Owner

(18)

1. That provision be made for weighing and recording the fuel used each shift or day.

2. That feed water be heated and measured.

3. That provision be made for adequate supply of air to the fuel, and convenient means provided for the measurement and control of the draft.

4. That provision be made to keep boiler surfaces clean inside and out.

5. That the grates be in good repair, that the settings, breechings and access doors be free from air leakage, and that boiler surfaces wasting heat be covered with insulation.

OUTLINE OF STANDARD QUESTIONNAIRE FOR THE UNITED STATES FUEL ADMINISTRATION COVERING OPERATION OF STEAM-POWER PLANTS

(This group of questions to be marked to form basis of rating of plant).

(a) FUEL:..... Value of Question 9.....Mark Rec'd.....

Question 1 - What provision is made for weighing fuel used each shift or day?

Question 2 - What records are made of fuel used each shift or day?

Question 3 - What grate surface is in use each shift, exclusive of banked fires?

Question 4 - Total coal used each shift exclusive of banked fires.

(b) WATER:..... Value of Question 15.....Mark Rec'd.....

Question 1 - What provision is made for heating and continuous measuring of feed water (check answer in table below)?

Heating	Means used for Measuring
Open feed water heater	
Closed feed water heater	
Exhaust steam	
Direct steam	
Waste heat economizer	

(c) AIR SUPPLY:.....Value of Question 12.....Mark Rec'd.....

Question 1 - Are means provided for measuring the draft over the fire?

Question 2 - Are means provided for determining the excess air by flue gas analysis?

Question 3 - Are dampers provided for equalizing the draft in the furnaces?

Question 4 - Is there a convenient means for regulating the draft by main or uptake damper?

Question 5 - Is there an automatic damper regulator in working order?

(d) CLEAN HEATING SURFACES: Value of Question 12 ....Mark Rec'd.....

Question 1 - What provision is made for keeping soot and ashes from boiler heating surfaces (mark answer in table below)?

Steam lance for blowing soot by hand	
Mechanical soot blower	
Brushes or scrapers	

Question 2 - How often are the soot and ash cleaned from the boiler heating surface?

Question 3 - What provision is made for keeping scale and sediment out of the boiler (check answer in table below)?

Chemical treatment of feed water in the boiler	
Chemical treatment of feed water outside of boiler	
Filtration of feed water in open feed water heater	
Filtration by means of feed water pressure filter	
Other means	
Water is free from scale or sediment without treatment	

Question 4 - What means are used for removing scale from the boiler?

Hand	Mechanical

(e) BOILER AND FURNACE SETTING: Value of Question 20....Mark Rec'd.....

Question 1 - Are the grates warped, broken or otherwise defective?

Question 2 - Check air leaks observed, as follows:

Leaks in boiler setting	
Openings between boiler and setting	
Badly warped fire doors	
Badly warped cleaning or access doors	
Leaks around blow-off piping	

(f) INSULATION.....Value of Question 7.....Mark Rec'd.....

Check any of the following items where saving could be made by covering surfaces with insulation:

Exposed drums of boilers	
Exposed shells of boilers	
Steam piping in boiler-room	
Steam piping in engine-room	
Feed water heater	
Exhaust steam piping where fuel could be conserved by covering	
Feed Lines	

(g) ENGINE-ROOM AND HEATING SYSTEMS: Value of Question 16 Mark Rec'd.....

Question 1 - Is exhaust steam used: entirely_____partly_____not used_____

Question 2 - State service for which this steam is employed: Heating____Cooking____Dry Room____Tank Heating____ Low Pressure Turbines_____ Other Purposes_____

Question 3 - Is there an excess of exhaust over requirements?

	Day	Night
Winter		
Summer		

Question 4 - Is there any low pressure live steam used in the plant?____ At what pressure?____lb. gage. For what purpose____Heating____Cooking____ Dry Room____Tank Heating_____Other Purposes_____

(h) SUPERVISION:.....Value of Question 10.....Mark Rec'd.....

Question 1 - Has the owner detailed a competent employee to supervise the work of fuel conservation in the boiler and engine plants with directions to report weekly on measures for economy and progress in conservation of fuel?

Name and title of this Employee_____

Question 2 - Has the owner appointed a man in charge of the work of fuel conservation outside of the boiler and engine rooms described under item (b) of Recommendation XIX(E)?_____

Name and title of this Employee_____

6. That the surfaces of steam piping, drums, and feed water heaters which waste heat or steam by radiation be properly covered with insulating material.

7. That exhaust steam be utilized wherever possible to the exclusion of direct steam from the boilers. The plant should be so designed that no more exhaust steam will be produced than can be efficiently utilized in heating or process work.

8. That a competent man in the plant be detailed for the work of fuel conserving in the boiler and engine rooms, and that a competent man or committee be detailed for the work of power conservation in the buildings or shops outside the power plant.

The eighth recommendation is important, as it is of little use for the power plant to be ideally efficient if the consumer is radically wasteful of the converted energy.

The first section of the Questionnaire asks for general information and should be answered very carefully.

Answering Questions

Numbers correspond to those on the blank form.

1. Calls for the name of the concern responsible for the power plant, whether owner or lessee.

2. This is the business address of the concern or person named in the answer to (1).

3. The commonly known name of the plant should be given, rather than any designation which is used for records.

4. In this answer indicate the general character of the plant, both of power generated and use made of it.

5, 6, 7. In answering these questions, the number of boilers of each size should be detailed and their individual horsepower, in the first two columns; thus assuming that there are six 500-hp. boilers in one bank, and two 600-hp. in another bank, it would be well to list them as

6-500 on the first line, and 2-600 on the second line, and in the eighth column to total up each line, making them respectively 3000 hp. and 1200 hp.; this refers to the rated capacity of the boilers. Now assuming that the boilers are being run at 300 per cent rating, then this should be brought out in the remarks, somewhat as follows: Running at 300 per cent rating; 9000 hp.

8. This question may cause confusion in some cases, in view of the fact that the Fuel Administration may have caused a change in the coal used in the power plant by reason of the zone system now enforced. Thus, in a case where for part of the year May 1, 1917, to May 1, 1918, the plant was utilizing anthracite and for another part bituminous, the answer should indicate, in the proper columns, the amount of each used, in tons of 2000 lb.

9. Note that tons of 2000 lb. are asked for, so that if the plant has been calculating or receiving its coal on the long ton basis, it should increase its fuel receipts to the equivalent number of 2000 lb. tons. This item should be the total of all kinds and sizes used.

11. Note that only *live* steam should be included. Any use of exhaust steam is not taken account of in this question.

14. This brings out whether regular written records are kept, as is customary in large plants of a commercial character. If records are kept of any of the items indicated, the answer should be YES for those items, otherwise it should be NO.

16. In answering this question, only those changes in actual progress are to be included; those anticipated may be included under remarks in question 18. As soon as contract is entered into for the changes, the changes may be considered to be in progress, or when tangible action is taken looking to the actual doing of the work.

The second portion of the questionnaire is given herewith, and deals with operation of the plant.

The power plant executive fills in the answers to questions, but does not fill in the line marked with the letters (a), (b), etc., as that will be done by the Fuel Administration.

Under Question 1 of (a) should be noted the kind of scales or means used for measuring the coal used before firing to the boilers. Thus if the scales are hand-operated, it should be so noted; if automatic, such should be noted, and so on; also the time of use. If no such means are used, simply answer, None used.

Under Question 3 only that grate surface in actual use should be noted; thus spare boilers with banked fires are not to be included, and in the matter of the grate surface, it should be that given by the boiler maker for the specific boilers in use.

The remainder of the questions can be readily answered, and where check marks are called for, this may be done by the ordinary check mark $\surd$ or by the use of an X. The other places which are not checked off should be filled in with a dash mark —.

Improving Factory Steam Plants

FIRST INSTALLMENT IN A SERIES OF PERSONAL EXPERIENCES IN ATTACKING PROBLEMS IN RUN-DOWN PLANTS. BY H. A. WILCOX

FOR the past few years a great deal has been written and a large number of lectures have been given on the subject of improving the efficiency of steam plants. I have read a large number of these articles and have attended a number of lectures, but it has invariably struck me that the subject has been treated from the wrong angle. Either central station practice is treated or the exact methods of attacking and solving the problems presented are hastily passed over and a generalization of treatment and results dwelt upon. The majority of us are interested in improving small factory steam plants and cannot go to great expense to purchase elaborate testing outfits. I am, therefore, relating a few personal experiences selected from a long list covering about 10 yr. of work in about 20 plants of various kinds, in the hope that others interested along the same lines may derive some benefit thereby. If the use of the personal pronoun is apparently somewhat frequent, it must be borne in mind that these are personal experiences and that its frequent use is almost unavoidable.

In nine cases out of ten, the factory manager calls for an investigation and improvement of his steam plant on account of a shortage of steam. The plant has perhaps been running fairly well for years, a little more steam consuming apparatus being added each year without having any noticeable effect upon the boilers. Suddenly, for some reason, the production of the factory is increased by one-half. At about this time trouble begins to develop in the steam end. Frequently the steam pressure drops, in spite of desperate efforts on the part of the fireman. This causes short shut-downs in some departments, which slows down production, in order to get the pressure back. After two or three occurrences of this kind, the manager calls the engineer on the carpet and talks to him like a Dutch Uncle. The engineer vents his spleen on the firemen and by frantic efforts better results are obtained for a short time. The trouble is only averted for a short time and soon appears again worse than ever.

Now, the manager hot-foots it down to the boiler room every time the steam goes below 100 and pitches into the first one he sees. After a few visitations of this sort, the men become discouraged. Some quit, some are fired. The engineer feels that his job is getting shaky and begins to look around for another position. The "don't care" and "can't help it" attitude is manifested in every part of the steam department. The plant acquires a bad name among outside firemen and good men are unobtainable, except at excessive wages.

Finally, with a return to sanity, the manager calls in the engineer and a conversation similar to the following takes place:

Manager—"John, what is the matter on your end these days? We have never had these troubles before and why have we run into them now?"

John—"For years our load has been growing. You have added a little here and a little there in the mill

with never a thought of buying a new boiler. You have spent thousands of dollars on new machinery in the mill, but you wouldn't give me a new feed-water heater 2 yr. ago when I told you and proved to you that it would pay for itself in a year. You said that you couldn't afford it on account of the expense of the new machines in the mill. You are the boss and I couldn't make you spend the money so I have had to get along the best I could. Now you have increased the production of the mill by one-half and the steam plant simply cannot keep up until you spend some money on it."

Manager—"Well, what do you suggest and what will it cost?"

John—"First, two new boilers and perhaps that will fix it. They will cost now installed about $7000 apiece. You could have put them in for $7000 for the two, 3 yr. ago when I spoke to you about it."

Manager—"When can we get them in and going?"

John—"In about six months."

Manager—"What can we do in the meantime?"

John—"I will do my best, but you will have to expect some shut-downs."

Manager—"All right, John. I will think it over and let you know about it in a day or two."

The manager then turns to other affairs and forgets about it. The engineer does not remind him, as he feels that it would appear too presuming on his part. In a short time, shut-downs appear so frequently that the manager remembers, and in desperation calls in the efficiency engineer in the hope that he will be able to get him out of his difficulties instantly. The manager does not care about expense now. He is making so much money that time is the prime element for consideration.

This is the exact point at which I have been called in on nearly every case which I have handled and is a typical illustration of conditions existing in nearly every factory in this country today.

Upon taking hold of a problem of this nature then, the first thing is to get the equipment into such a condition that shut-downs on account of low steam pressure will be cut out or their frequency lessened and this end must be accomplished within the shortest time possible. Afterward the general efficiency of the plant may be slowly built up to standard. I will, therefore, endeavor to show exactly how this was done in a number of cases which I have been called in upon.

Case Number One

At this plant there were no engines, live steam at 100 to 120 lb. pressure, from 60 to 75 lb. pressure being used for manufacturing purposes. Power to run the mill and for lighting was taken from the central station in the town. In any extent, exhaust steam was unavailable and could not have been used anyway, due to a clause in the contract under which the product was sold which prohibited the use of steam under 60-lb. pressure.

Stated succinctly, the problem was this: It was necessary to clean the fires every 6 hr., the plant being run 24 hr. every day in the week, including Sunday and every time the fires were cleaned, a part of the plant had to be shut down for about 1½ hr. in order to get the steam pressure up again. This, of course, cut down heavily on production and demoralized the routine of the plant.

I was given these facts and told to "go to it." Expense was a negligible factor and the element of time only was to be considered. A concession was made to me that I might have from 12 o'clock Saturday nights until 10 o'clock Sunday mornings for cleaning boilers and making necessary repairs. This practice would be continued after I got the plant running properly, if necessary.

I arrived on the job with a 1½-in. hot water meter, two or three homemade draft gages, a few coal sampling cans, an electric pyrometer and an Orsat.

The first day was spent in looking the plant over and talking with the fireman, superintendent and master mechanic. I was trying to get some exact information about the trouble and to get these men (diplomatically) to work with me toward the alleviation of the trouble. Due to labor conditions during the last two or three years, this last was one of the most important methods for overcoming the trouble. Given an ideal plant and ideal conditions, the best results will not be permanently obtained until all the men working on the job are pulling together toward one common end. Too great emphasis cannot be placed upon the above fact.

My thorough examination of the plant including boilers, all steam piping, all auxiliaries, all steam using apparatus and the heating system disclosed the following facts, which were carefully set down in detail in a large note book, with sizes and sketches of some of the details:

1. Steam was generated by three boilers.
   (a) One water-tube boiler, about one year old.
   (b) Two horizontal return tubular boilers from 25 to 30 yr. old each.
2. Soft coal was used and 120 lb. was the standard pressure for the water-tube boiler while the horizontal tubulars operated at 60 lb. Hand-feeding and hand-firing were depended upon.
3. There was one duplex feed pump for all three boilers, although city pressure could be used when the pressure was below 80 lb. There was no relief valve on the discharge of the pump.
4. An open feed-water heater, about a year old, was connected to the suction of the pump and a feed temperature of 180 deg. was ordinarily maintained. Anything above this temperature caused the feed pump to race. Steam for heating the feed water was obtained from the exhaust of two duplex pumps which pumped water from a canal for manufacturing purpose. City water was used for make-up in the heater, although it was piped to use canal water which cost almost nothing as compared with the price paid for city water. The oil separator on the heater was depended upon for eliminating oil in the exhaust steam. Returns to the heater came from two large driers which were supplied with steam from the water tube boiler at 120 lb. and constituted the main load of the plant. All other returns were thrown away.
5. Very little of the steam piping was covered and long, round about runs with plenty of 90-deg. bends were sprinkled around on all sides. A profusion of unnecessary valves and fittings was evident.
6. The pumps, used to supply canal water for manufacturing purposes as mentioned previously, were oper-

ated continuously and discharged into a large tank on the roof, any overflow being allowed to run back into the canal.

7. In addition to the above pumps, a centrifugal pump run by a clutch attached to the main shaft supplied canal water to a tank at a lower level than the tank mentioned above. Great care was exercised to keep this pump in continuous operation as it took from one to two hours to get it going again if once stopped. The pump was very large for the work and as a result almost half the water it raised flowed back to the canal from the tank.

8. Numerous small but detrimental conditions were found to exist which will be treated in the pages to follow.

My talk with the men brought to light the following somewhat meager information:

1. That the trouble with low steam pressure was a comparatively recent development and began about two months previously.

2. That for the last two months the plant had been turning out twice its regular production.

3. That the heaviest load was two driers.

4. That the water-tube boiler was equipped to burn hard coal in the beginning. At first, hard coal had been used and then soft coal was tried in order to maintain the required pressure.

5. Everyone was absolutely sure that the boilers were overloaded and that the installation of another water-tube boiler as large as the present one was the only way to overcome the difficulty.

With all this information in hand I set to work on the problem.

I had the Orsat set up and introduced my hot water meter into the feed line of the water-tube boiler as the other boilers were giving no cause for complaint. For two or three days I took frequent Orsat readings and kept track of the amount of feed water used hourly. In addition, I kept going around the plant and tracing out the various pipe lines. Incidentally, I watched the work of the fireman closely and noted the behavior of the steam pressure, especially while the fires were being cleaned. During all this time I did not say anything as to my ideas for correcting the evil, although many anxious inquiries were made by both superintendent and men.

My object in proceeding in this way was fourfold:

First—I wished to determine the actual load upon the boiler, by means of a water meter.

Second—I wished to determine whether the method of firing was anywhere near efficient.

Third—I wished to get the piping system and the details of operation firmly fixed in my mind as I thought that perhaps part of the trouble might be located in this direction.

Fourth—I wished to accustom the fireman to my presence in the boiler room and to the instruments I was using so that later on he would not feel that he was being watched and would do his work in the regular way whether a test was being run or not.

At the end of the third day I had added the following facts to my collection. (At this point, I may say that at the start, I wrote to the maker of the boiler and obtained a blueprint of the boiler, giving dimensions, rating and other details.)

First—My meter showed that the boiler was not being run up to rating, about 200 hp. being the maximum horsepower-hour, while the boiler was rated at 228 hp. This rating being based upon ten square feet of heating surface per boiler horsepower.

Second—Much to my surprise, the Orsat showed exceedingly good readings, anywhere from 12 to 15 per cent of CO_2 being regular, with no CO. Of course, this fell off when the fires were being cleaned and no readings were taken at this time. I also noticed that no attempt was being made to feed the boiler regularly; first the high and then the low water alarm on the column was frequently blowing.

Third—I found that each drier contained about 11,000 linear feet of 1¼-in. pipe, the condensation from which was taken care of by 10 bucket traps to each drier. The traps, 20 in all, discharged into the open heater, which showed a pressure of about 5 lb. at all times.

Heating in the mill was obtained from coils, carrying steam, reduced through a valve, from 120 to 8 lb. and the returns were discharged into the canal.

The atmospheric relief valve connected with the open heater was out of order and the exhaust head was continually discharging large quantities of steam.

The packing would not stay in the water end of the feed pump for more than a few hours at a time and frequently got into the feed line and choked it up.

Charcoal from the heater frequently got into the pump and caused trouble. The overflow valve on the heater was constantly open, allowing hot water to flow to the canal.

There was no damper in the stack of the water-tube boiler as it was cut out some time previously. This was done because the stack frequently became red hot for a distance of 30 ft. above its base when the boiler was forced with a new fire and flames came out of the top of the stack. The men thought the damper might be partially closed at times and were taking no chances. The stack set upon the breeching of the boiler.

Fourth—The fireman became accustomed to the testing of the boiler and performed his duties in the regular way. Although his methods would stand a little improvement, I could see no glaring faults here, except great irregularity in feeding the boiler as mentioned previously.

During the last few days of this first week I ran several short but complete evaporative tests upon the boiler as I wished to have some records for comparison later on. In other words, I wished to be able to demonstrate conclusively the value of changes made, after my work was done; to have records to indicate whether each change was an improvement or was detrimental after it was made; and records to show the gain made in efficiency when the time came to install efficiency methods. It might be interesting to state that these tests showed an equivalent evaporation of from 6 to 7 lb. of water per pound of coal and that my pyrometer indicated a temperature of from 900 to 980 deg. F. in the breeching at times during the tests.

This concluded my work for the first week and on Sunday I made a complete internal and external ex-

amination of the boiler, with the following results:

External—1. Grates, stationary, with 3/16-in. openings, majority of them stopped up.

2. Interior of fire-box needed re-lining, including new door arches.

3. Combustion chamber, filled to a depth of 2 ft. with dirt.

4. Forced draft could be obtained by the use of two Argand steam blowers, cemented into the ash pit.

5. Tubes covered with soot.

6. Boiler was horizontally baffled, lower rear retaining plate had burned away and part of the lower baffle had slipped back against the rear water leg. A large number of baffle brick were missing in both lower and upper baffles, allowing plenty of short circuits for the gases.

7. In this type of boiler, the water leg staybolts had a hole running clear through them for soot blowing purposes. In operation, these holes were supposed to be plugged. Half the plugs were missing.

8. Soot to about one foot in depth entirely covered the upper baffle.

9. Setting was of brick and was badly cracked in a number of places.

Internally—1. The tubes were 4 in. in diameter by 18 ft. long. Almost every tube contained a layer of extremely hard scale, varying in thickness from ¼ to 1¼ in.

2. The drum was about 4 ft. in diameter and ran longitudinally, having a manhole in the front end. The fusible plug in the drum was corroded and apparently useless. The interior of the drum had a coating of scale about ⅛ in. in thickness, similar to that in the tubes.

3. The mud drum, blowoff pipe and surface blowoff were filled full of scale.

4. The feed pipe had broken off just inside the front head.

This completed my examination of the plant and I only had to analyze the accumulated mass of information and set about correcting the evils.

I have been careful to set out in full detail all the steps in this investigation as it is of the utmost importance in all cases and the care exercised in making it governs the results afterward attained. As an old chief engineer in a large plant once told me, "Engineering is nothing but careful analysis and then applying common sense to fit the problem."

I will now proceed to set forth how I applied the common sense. In order to be brief, I will set down simply the steps taken and the reasons for taking them without including too many figures. It must be understood that a great many of the changes mentioned were made simultaneously so that the entire job did not take so long a time as might appear from reading this article. Neither have I tried to set down the changes in the chronological order in which they were named.

From the foregoing details, it would seem as if this plant were in the last stages of neglect and decay; but I regret to state that I have found many more plants in a like or worse condition and that the condition of the above plant averages up pretty well with a great many other plants in this country today as cases two and three will demonstrate.

To proceed to the treatment in this case: I could easily determine, from an analysis of the information collected, where part of the trouble lay and started out to correct this at once. I made all changes step by step and paused to observe the result of each change before making another. I have found that many times, in order to make a quick "showing," several changes are made at the same time. As no two plants ever have exactly the same conditions, frequently one change will neutralize the other and both are discarded as worthless when one of them was good if time enough had been taken to find it out.

I first connected a large bypass to the canal from the discharge of the 20 traps on the two driers. Observation of the open end of the bypass quickly demonstrated that nearly all the traps were blowing by live steam. I sent for the dealer who handled the traps. After examination, he reported that the traps were designed for low pressure work and were being used with high pressure. Incidentally, he stated that the order for the traps was given by a firm of consulting engineers who refused to specify under what conditions they were to operate. In order to get rid of the attendant steam leaks and maintenance troubles of 20 traps, they were replaced with four high-pressure traps of a size sufficient to take care of all condensation. The results of this step clearly demonstrated progress, as the steam pressure could be maintained better.

Next all returns were collected and sent back to the open heater, which was opened up, carefully cleaned and adjusted. The valve on the atmospheric exhaust was repaired and the suction line to the feed pump was cleaned out as it was half full of charcoal from the heater. After this, a feed temperature of about 200 deg. F. was easily maintained with little or no exhaust steam escaping from the roof.

Trouble at once developed with the feed pump racing. Examination showed that the pump was set higher than specified by the heater people; the follower of one of the water pistons was jammed; the linings of the water cylinders worn out of shape; and the use of improper packing.

The pump was lowered two feet, thus putting a head on the suction. A pump governor was installed; new linings were put in the water end; new valves put in; a new follower put in; and the proper packing put in. This smoothed out all difficulties as far as feed water was concerned.

In addition, the pipe supplying canal water to the heater was found to be plugged up and was replaced in working order, thus eliminating the use of city water. The overflow valve on the heater was ground in and adjusted so that it seldom if ever opened. Steam and water piping throughout the plant was re-arranged at different points, lines being shortened and 45-deg. elbows or long turn bends being substituted wherever possible. Practically enough pipe and valves were saved from these changes to pay for the cost of making the changes.

The results of these changes having been determined, the next step was to tackle the water-tube boiler itself. My previous examination and tests had already indicated the troubles there. Perhaps the reader will think "He ought to have tackled the boiler first." It must

be remembered that the boiler could be worked only on week ends and in numerous instances I have found that 75 per cent of the trouble lay in the steam consuming rather than in the steam producing end of the plant. Furthermore, I knew that the correction of the boiler evils would make such a large improvement that the other work might be neglected and left as "good enough." If this were the case, more trouble would soon develop, which would be harder to locate. Finally, I like to proceed toward a climax, attaining my best results at the end as the last work which is done is usually best remembered. Of course, where extremely quick results are demanded, this cannot always be accomplished.

Calculation of the proportions of the boiler indicated that the grate surface was much too small and that the grates were not adapted to burning soft coal. Due to certain peculiarities of setting, it was impossible to lengthen or widen the fire-box. Therefore, there remained but two ways to increase the grate surface and so burn more pounds of coal and get more horsepower per hour.

First—The installation of new grates, preferably stoker type.

Second—The application of additional draft.

The plant was too small for an engine driven stoker, so a hand operated stoker was installed. On this stoker the grates were pitched at about 45 deg. from the horizontal and the fire-box was widened slightly. In this way several more square feet of grate surface were obtained.

The steam blowers were removed as being too small and too uneconomical with steam. I think that it is an accepted fact that such blowers take for operation about 10 per cent of the steam generated. In their place, the discharge from a large ventilating fan, already running, was introduced.

In the meantime, the boiler was given a thorough renovating from top to bottom, as follows:

1. Fire-box re-built and door arches renewed.
2. Bridge wall re-built and moved back one foot.
3. New top and bottom baffles installed throughout and the lower baffle properly tied in at the rear end to prevent its slipping off.
4. Combustion chamber thoroughly cleaned out.
5. Outside of tubes cleaned.
6. Asbestos plugs made and put in staybolt holes.
7. Drum cleaned out inside.
8. Mud drum and blowoff pipes cleaned out.
9. Fusible plug renewed.
10. Damper placed in stack.
11. Tubes drilled out with turbine driven cleaner. This operation took 72 hr. of continuous work. Four wheelbarrows of scale removed.
12. Damper regulator, feed-water regulator, and latest type of soot blowers installed.
13. Setting was pointed up.
14. An entire new set of asbestos gaskets placed on the tube caps.

To accomplish all this work, it was of course necessary to shut the plant down flat for several days. The jobs were all planned out on paper beforehand, the required number of men and material and the time allowance for each job being carefully estimated and set down. As a result, all these changes, including the stoker installation, were carried out in a space of 96 hr. and the changes were all completed about ¾ hr. later than the schedule called for.

When the fires were started again and everything got to running smoothly, it was found possible to lift the safety valve at any time without effort. After a few days, another series of evaporative tests were run and a gain of 10 per cent in thermal efficiency was found.

After this, a system of daily logs was installed together with a number of reminders to the master mechanic which come out at definite intervals of time to remind him to clean the boiler, etc. These reports were made returnable to headquarters when signed and thus headquarters is kept in close touch with the daily operation of the plant.

A feed-water meter has since been installed at this plant and a mixture of soft coal and anthracite culm has been introduced with great success and has effected a material saving in fuel expense.

The writer has not touched upon his treatment of the remaining boilers as only a few minor changes were found necessary.

All of the foregoing improvements cost considerable, but they saved the installation of a new boiler at a prohibitive expenditure of time and money. By speeding up the fan, supplying forced draft, the water-tube boiler could easily do 150 per cent rating, whereas at present it is doing only about 100 per cent. In fact, the writer was able to carry the entire load on this one boiler for several days simply by urging the fireman to a little extra effort, but owing to the present labor situation, this was discontinued.

Cases two, three and four will differ materially from case one in a number of respects and while the writer has gone into great detail in case one, he will be more brief in the remaining cases as case one fully outlines his method of attack.

Engineer Officers Wanted

TRAINING camp for officers in the Engineering Corps will be opened at Camp Humphreys, about 17 miles south of Washington, about Aug. 1. Two thousand candidates for positions as 1st lieutenants and captains will be trained with the same facilities provided as for training the 17,000 engineer replacement troops now preparing for overseas service.

Some fifteen special schools will be provided in mining, quarrying, gas and flame defense, barbed wire fortification, water supply and railroad transport. Candidates for lieutenancies must be between 32 and 36 yr. old; for captaincies between 36 and 42. A traveling examining board headed by Maj. E. H. Williams will visit the larger cities to pass on qualifications of candidates.

Applications giving details of qualifications should be sent to Gen. Wm. M. Black, Chief of Engineers, Seventh and B Sts., Washington, D. C., and marked "For Attention of Maj. E. H. Williams."

Oil Engines---III

Fuel Supply Control

VARIOUS means are employed to control the fuel supply. Generally, this is accomplished by altering the stroke of the fuel pump, by varying the opening period of the fuel pump suction valve, or by providing a bypass valve and an overflow chamber whereby the flow of oil may be diverted from the injection valve according to the load on the engine.

Power and Efficiency

As with any kind of motor or prime mover, operators of internal combustion engines are vitally concerned in the amount of power actually delivered, or in other words, the brake horsepower. Ordinarily, and especially in the smaller sizes of engines, this is determined by means of a Prony brake such as illustrated in Fig. 15. Essentially this consists of a band, *B*, of wooden strips reinforced by steel straps, or preferably, of a length of woven belting to the ends of which are riveted plates forged to adjusting screws *S*, fitted to an arm, *A*, in the manner indicated. Attached to this arm is a block, *E*, cut out to the radius of the wheel so as to provide a substantial bearing surface. Power is absorbed by friction of the band on the wheel and by proper adjustment of hand wheel *D*, the degree of friction may be varied so as to give any desired scale reading. The brake horsepower may then be determined readily by the employment of the equation:

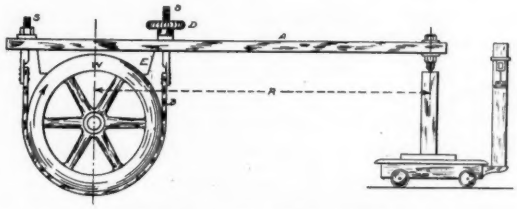

FIG. 15. THE PRONY BRAKE

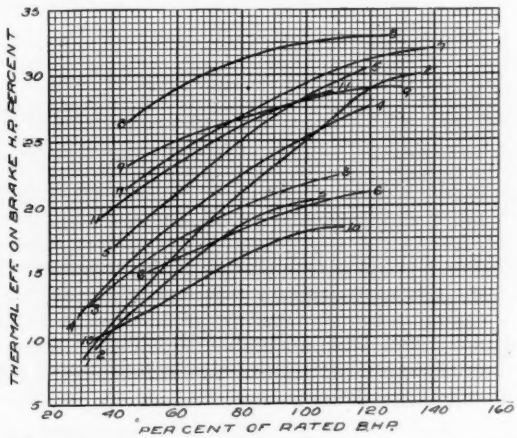

FIG. 16. EFFICIENCY CURVES OF VARIOUS TYPES OF INTERNAL COMBUSTION ENGINES

$$\text{Brake horsepower} = \frac{2 \times 3.1416 \times F \times R \times N}{33{,}000}$$

in which F is the force measured by the scale in pounds and at a distance, R, from the center of the shaft to the center line of the knife edge and its support resting on the scale platform, and N is the number of revolutions per minute; 33,000 is a constant, the number of foot-pounds per minute equivalent to one horsepower.

Since the denominator is in foot-pounds per minute, it is obvious that the numerator must be expressed in like units. And, as the unit of work employed is the foot-pound, R must be expressed in terms of feet, thus giving as the distance for one revolution, $2 \times 3.1416 \times R$, and for N revolutions, $2 \times 3.1416 \times R \times N$ as the distance moved through per minute. Multiplying the product obtained by F in pounds as measured by the scales, or $2 \times 3.1416 \times R \times N \times F$, we have the total number of foot-pounds of work which, divided by 33,000 will give the horsepower absorbed.

When the engine under test is used to drive an electric generator, the horsepower delivered by the engine may be more accurately obtained from the electrical output of the generator, making due allowance for the efficiency of the machine. In order, however, to enable one to calculate the mechanical efficiency of an engine, it is necessary to know the power actually generated within the cylinder or the indicated horsepower. This, as its name implies, is obtained in a manner similar to that employed in connection with a steam engine, the formula for which is: Indicated horsepower $= \frac{P l a n}{33{,}000}$; in which P is the mean effective pressure in pounds per square inch; l is the length of stroke in feet; a is the area of the piston in square inches, and n is the number of working strokes per minute. Due, however, to the fact that not every stroke of an internal combustion engine is a working stroke, n in this type of engine must represent the number of cycles per minute which in the case of a two-stroke cycle, single-acting single-cylinder engine would be half the number of strokes per minute, while in a four-stroke cycle, single-acting, single-cylinder engine the number of cycles would be one-fourth the total number of strokes. For double-acting engines, the working strokes would be twice the above values. Letting the number of cycles per minute be represented by n′ and the number of

Curve No.	Type of engine	Rated B.hp.	Rated r.p.m.	Fuel	Governing system
1	Deutz, single cylinder	50	200	Illuminating gas	Throttling gas
2	Westinghouse, 3-cylinder vertical	100	270	Natural gas	Throttling mixture
3	Deutz	450		Producer gas	
4	Güldner, single cylinder	35	220	Producer gas	Throttling
5	Nürnberg	1200	106	Blast-furnace gas	Throttling gas
6	Swiderski, single cylinder	15	235	Alcohol	Throttling
7	Deutz, single cylinder	13	285	Alcohol	Throttling
8	Diesel	70	168	Russian kerosene	Cut-off
9	Diesel	8	375	Kerosene	Cut-off
10	Hornsby-Akroyd	35	203	Kerosene	Regulating oil
11	Hanki	25	210	Gasoline with water injection	Hit-and-miss

FIG. 17. DATA ON ENGINES REFERRED TO IN FIG. 16.

cylinders employed by k, we may use the following formula for any single-acting four-stroke cycle engine having k cylinders: Indicated horsepower $= \frac{k P l a n'}{33{,}000}$; where P, l and a are the same as in the previous formula.

Mechanical efficiency is the ratio between output and input or, in the case of an engine, the ratio between the brake horsepower and the indicated horsepower.

Field	Gravity Baumé	Specific gravity at 15 deg. cent.	B.t.u. per lb.	Wt. per gal. lb.	Ultimate analysis C	H	S	N	O	Undetermined	Ash per cent.
Kern River, Cal.	14.78	0.9670	18,583	8.06	86.56	11.37	0.74	0.39	....	0.74	216
Colinga, Cal.	17.22	0.9608	18,720	7.98	86.37	11.50	1.14	0.60	....	0.69	168
McKittrick, Cal.	18.83	0.9480	18,956	8.00	86.81	11.41	0.68	0.74	....	0.76	168
Midway, Cal.	16.14	0.9580	18,846	7.98	86.86	11.61	0.74	0.09	....	0.86	148
Sunset, Cal.	14.86	0.9708	18,819	8.09	86.64	11.37	0.84	1.06	....	1.09	180
Beaumont, crude.	21.8	0.924	19,080	7.69	84.6	10.90	....	1.63	2.87	....	....
Beaumont, crude.	21.5	0.926	19,481	7.71	83.8	12.41	....	0.80	3.08	....	....
Temple, Crude.	18 to 23	.....	18,493	7.93	83.6	12.3	1.7	2.9	0.48	....	....

FIG. 18. CHARACTERISTICS OF AMERICAN FUEL OILS

In addition to the power absorbed in bearing friction, that required for opening the valves, operating the governing mechanism, oil, feed and scavenging pumps is instrumental in causing a greater or less difference between the indicated and the brake horsepower, and it is primarily due to these additional functions that for like sizes the mechanical efficiency of the internal combustion engine is less than that of the steam engine.

A set of efficiency curves of various sizes of internal combustion engines, as given by Carpenter and Diedrichs, "Internal Combustion Engines," are shown in Fig. 16. The types of engines referred to, the brake horsepower, the speed, the kind of fuel used and the form of governing employed is as indicated in the table, Fig. 17.

FUELS

PRACTICALLY any combustible liquid can be used as fuel if properly vaporized and when employed in an engine adapted to it. Generally, however, this is a mineral oil either in the crude state or a derivative obtained by fractional distillation, and while much of that produced in the United States is obtained from Pennsylvania, Ohio, Indiana and Oklahoma, the largest fields are found in Texas and California. The composition of these oils varies somewhat. As a rule the specific gravity lies between 0.80 and 0.97, the flash point between 76 and 93 deg. F., and the composition by weight is 84 to 88 per cent carbon and 11.5 to 14.5 per cent hydrogen with a small percentage of impurities. Analyses and calorific values of various American and foreign crude oils and their derivations are shown in Figs. 18 and 19.

	Specific gravity	Composition by weight S	C	H	O + N	High heating value B.t.u. Observed	Calculated
Russolene	0.890	....	85.95	13.50	.....	19,628	19,825
American kerosene	0.780	....	85.05	14.40	.....	20,093	20,250
Russian crude	0.877	....	86.90	13.10	.....	19,500	19,706
Java crude	0.867	....	87.10	12.70	.....	19,177	19,490
Canadian crude	0.859	0.35	86.92	12.87	.....	19,436	19,571
Texas crude	0.947	0.63	86.62	11.80	.....	18,931	19,878
Solar oil	0.896	0.30	86.61	12.60	.....	19,409	19,384
Coal oil	0.917	1.56	83.30	11.87	.....	18,401	18,461
Russian crude, Caucasian	.....	....	84.90	11.65	1.46	18,690	18,641
American Royal Daylight	0.797	....	85.70	14.30	.....	20,101	20,214
American crude petroleum	.....	....	86.894	13.107	.....	19,642	19,712
Refined American petroleum	.....	....	80.585	15.10	4.32	19,955	20,074
Refined Russian petroleum	0.886	..	86.00	14.00	.....	20,286	20,285

FIG. 19. CHARACTERISTICS OF AMERICAN AND FOREIGN FUEL OILS

The heating values of these oils, as those of any other kinds of fuel, are more properly and accurately obtained by the use of the calorimeter, although for all practical purposes we may use either one of the two following formulas: B.t.u. per lb. $= 13{,}500\ C + 60{,}890\ H$, in which C and H represent respectively the parts by weight of carbon and hydrogen present, or, B.t.u. per lb. $= 18{,}650 + 40 \times$ (Baumé reading $- 10$).

The heavier the fuel the more finely it must be divided when injected into the cylinder in order to insure proper vaporization. If this is not done, the comparatively large particles will burn on the surface only while the center will be converted into a pitchy substance which will adhere to the inner walls of the cylinders and valve disks and seats, and as a consequence will tend to cause considerable trouble.

Up to a full load, the fuel consumption of an internal combustion engine varies inversely with the load, tests indicating the Diesel engine to require at one-fourth load from 1.40 to 1.90 times the amount of fuel per horsepower taken at full load; at one-half load, the requirement is from 1.07 to 1.25 and at three-fourths load from 1.02 to 1.15 times that at full load.

THIS TABLE, compiled by The Richardson-Phenix Co., shows the amount of oil that should be supplied to steam engines of various sizes. It is figured out for medium speed simple Corliss engines and the quantities should be increased about 30 per cent for high-speed engines. For cross compound engines, the amount of oil necessary is arrived at by figuring out the amount of oil required for two engines, each having half the capacity of the main unit; that is, a 1000-hp. cross compound engine would require as much oil as two 500-hp. simple engines, or 24 gal. per hr.

ARE YOUR ENGINES GETTING THIS MUCH OIL?

ENGINE HORSE POWER	MINIMUM HOURLY FILTERING CAPACITY NECESSARY GALLONS	ENGINE HORSE POWER	MINIMUM HOURLY FILTERING CAPACITY NECESSARY GALLONS
100	4	750	17
150	5	800	18
200	6	850	19
250	7	900	20
300	8	950	21
350	9	1000	22
400	10	1050	23
450	11	1100	24
500	12	1150	25
550	13	1200	26
600	14	1300	28
650	15	1400	30
700	16	1500	32

For engines over 1500 HP allow 6 gallons per hour for each 100 HP.

AN AMERICAN correspondent tells us that our boys in France are always smiling, even when they enter the trenches, when they charge, and when they return from battle. If they can face death with a smile, certainly we can do our part at home without grumbling. And that part consists in producing all possible, consuming as little as necessary, and buying War Savings Stamps with our savings.

Blocking New Wars

FIGHTING FOREIGN WARS AT HOME. ECONOMIC PRESSURE TO AVOID USING MILITARY POWER. COST OF PREVENTING WARS VS. COST OF WAGING WAR. BY HERBERT S. HOUSTON, MEMBER OF THE CHAMBER OF COMMERCE OF THE U. S. A., ON ECONOMIC RESULTS OF THE WAR*

ONE of the manifest advantages of economic pressure as an international force is the way it can be applied. Each of the nations in a league can apply it instantly from within, and the moment the announcement is made that an embargo has been declared, pressure begins to be exerted. It is not necessary to spend billions of dollars and years of time in building armament and creating armies, as is the case in developing effective military power. The modern world is prepared to exert economic power instantly. Preparation has been made through the agencies of commerce and in every nation machinery is at hand through which economic pressure could be applied. The stock exchanges, the cables, the wireless, the international postal service and the wonderful modern facilities, already referred to, for communication and intercommunication constitute this machinery. It is world-wide in its extent and it would become operative the moment a league of nations decided to set it in motion.

This marked advantage, which economic power possesses over military power, has never been appraised at its full value. But one needs only to read the briefest survey of the time and money required to organize military power in England and the United States during the great war to be convinced that at least in this important particular of immediate availability, economic power has an overwhelming advantage. As Secretary of War Baker stated in his testimony before the Senate Committee on Military Affairs, even with the aid of a draft law it required all the time between April, 1917, and Jan. 1, 1918, to raise the armed forces of the United States from 9524 officers to 110,856 officers and from 202,510 to 1,428,650 men. And despite the fact that the manufacturing power of the nation was being exerted to the utmost to equip this army during the period in which it was being mobilized, the time was not sufficient to bring this equipment to the proper standard at the beginning of 1918. Military power today represents not merely man power, but the organized industrial power of a nation. That has been established in the experience of every belligerent country, and it is now everywhere conceded. Even when the military power is organized and equipped, a considerable time is required, for the transportation of men and supplies, before it can be effectively used. Warships and transports must be sent across the sea or endless trains must bear soldiers and munitions to the scene of hostilities before military power can be employed to advantage. But economic power, on the other hand, as has been pointed out, can be applied instantly from within by every nation and its effect becomes instantly apparent.

This comparison is not developed as an argument against military power but only to make clear the fact that economic power in the modern world has certain clear and great advantages over military power. In most of the proposals for a league of nations to follow the war, the use of military power, either exclusively or as a last resort, is provided for. In the program outlined by the League to Enforce Peace, economic pressure is presented as an international force to be used before military force is employed. So it becomes pertinent to outline the advantages possessed by economic power, although making clear that it should never be looked upon as the final but only as a preliminary power. There is strong reason to believe, however, that in many cases the use of economic pressure as a preliminary power would be sufficient to bring a recalcitrant nation to a world court for a settlement of its differences, thus avoiding the use of military power altogether.

In addition to the agencies existing today through which economic pressure could be applied, new agencies would doubtless be formed in connection with a league of nations. An international clearing house has been proposed as an essential piece of machinery for the service of commerce in any world organization that would follow the war. An able Chicago banker, John J. Arnold, vice-president of the First National Bank of that city, a man who is considered a master of the intricacies of international exchange, has long urged the desirability of an international clearing house. Such a clearing house would settle balances between nations just as our modern clearing houses now settle balances between banks in cities in which they are located. Beyond question such an international clearing house, when established, would quickly become a powerful auxiliary agency in the League of Nations, helping to give it stability and serving, when occasion arose, as a new instrumentality by which economic pressure could be applied.

When George B. Cortelyou was Secretary of the Treasury in President Roosevelt's Cabinet, he proposed that international gold certificates might be secured by gold deposits made by the various commercial nations and that these certificates could be used in settling

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trade balances, thus avoiding the delay and danger of transporting the actual gold. The Federal Reserve Banking System, which has been working with distinct success in the United States, might suggest a model for an international banking system to accomplish the purpose which Secretary Cortelyou had in mind. If this took the form of an international clearing house, in which each nation should make deposits of gold in direct proportion to the volume of its foreign trade, it is manifest that a piece of powerful international machinery would be established that could perform prompt and important service for a league of nations. As an illustration—if a nation sought to make war, in defiance of its pledge to seek adjudication of its differences before a world court, it would, as an automatic penalty, forfeit its gold deposits with the International Clearing House and also its trading rights and privileges as a member nation. The procedure and penalty would be similar to the suspension or expulsion of a member by a stock exchange.

Such a clearing house would be an agency to aid in preventing war and, what is even of greater importance, it would be a powerful agency to aid in promoting peace. For the advantages of being a member of such a world clearing house would be so great—in fact, so vital—to every nation that it is hard to believe that they would be surrendered, except as a final resort in a desperate situation. The alternatives would be, the way of law and honor with trade advantages held, or the way of war and broken faith with trade advantages lost. To cause a nation to pursue the second way would require the force of such an overwhelming demand for war, among its own people, that nothing could resist it. Of course such a situation is not only conceivable but it is one that will recur, until the practice and the spirit of peace have become part of the consciousness of the world.

War Prevention Versus War Cost

One apparently strong and valid argument to be brought against the use of economic pressure is that it would bring great loss to a nation applying it. And that is true. But it is equally true that this loss would be far less than the loss brought by war. The appropriations of the United States for war purposes in 1915, a year after the great war broke, but two years before we entered it ourselves, were $158,000,000. For the year 1918, the war appropriations have already reached the great total of $7,527,338,716. This vast sum, fifty times greater than the sum appropriated in 1915, represents the war cost for only a single nation. The annual cost of the war of all the nations engaged in it is many times that sum. And the total cost of the war from the beginning represents a sum equal, undoubtedly, to the value of all the products of all the belligerents for a generation. At the beginning of 1918 it was estimated, after careful computations, that the cost of the war to Germany represented one-third of the total wealth which the German empire had built up through centuries. And the cost to the other nations is relatively as great. In comparison to the staggering sums involved, the loss to commerce from the application of economic pressure would be extremely small. This would be true even if the entire export and import trade of all the belligerent nations should be sacrificed.

In 1912 the imports of France amounted to $1,588,553,000 and the exports to $1,295,528,000. The imports of Germany for the same year were $2,544,557,000 and the exports $2,131,718,000. The imports of Austria-Hungary were $722,030,000 and the exports $554,973,000. For the United Kingdom the imports were $3,623,794,000 and the exports $2,371,073,000. Italy's imports were $714,471,000 and exports $462,607,000. Japan's imports were $308,258,000 and exports $261,258,000. The United States had imports of $1,653,265,000 and exports of $2,170,320,000.

These great totals represent much less than the yearly cost of the war to each of the belligerents. The official figures issued by the United States Treasury Department, giving the cost of the European war up to Aug. 1, 1917, showed that the expenditures of the United Kingdom aggregated $26,705,000,000, and that the daily war cost was $25,000,000. For France, the total expenditures had been $16,530,000,000 with a daily war cost of $18,500,000. For Italy the aggregate cost was $5,050,000,000 with a daily expenditure of $7,000,000. With the Central Powers, Germany had made aggregate expenditures reaching $19,750,000,000 with a daily cost of $25,000,000, the same daily cost as that of Great Britain. Austria-Hungary had war expenditures that equalled $9,700,000,000, with a daily war cost of $13,000,000. As 1918 opened, the daily cost of war to the United States had mounted to the same great total of $25,000,000.

The statement of these figures makes clear the wide disproportion between the cost of war and the cost of preventing war through the use of economic pressure. But manifestly it is a false assumption to say that the nations in a league would have all their outgoing and incoming commerce destroyed when they joined in applying economic pressure to a recalcitrant member. The most that could happen would be the total loss of trade which each nation in the league had with the nation against which economic force was being directed. To some degree this loss would be met by increased trade among the nations of the league with each other, but for the purposes of a comparison we shall give to war the benefit of every possible doubt and assume that the entire volume of trade which the recalcitrant nations had with the other members of the league would represent a complete loss. Even on this basis it is apparent that the cost of a war that might possibly be avoided is very greatly in excess of any conceivable loss that might be entailed through the application of economic pressure.

The trial balance that is being considered is of commerce alone and no account is being taken of the destruction of life and the other great human losses that come with war. But this strict commercial accounting shows a heavy debit against war.

A criticism has been made of the use of economic pressure by Hamilton Holt, the able editor of The Independent, and by others to the effect that the burden, in applying economic pressure, would be borne unequally by the signatory nations. It has been pointed out that a small nation, in a given case, might suffer a greater trade loss than a large nation, and this is possible. But this inequality can be met by making the share of the total loss of trade which each nation would bear di-

rectly proportionate to the amount of its foreign trade. By thus pro-rating the loss on the basis of the ability of each nation to bear it, absolute fairness would be secured. The League of Nations which would apply the economic pressure could equitably determine the amount of the resulting loss which each nation should assume. Even if this were not done the loss to each nation would be far less than the loss which would be entailed by war; so, it is reasonable to expect, few controversies would arise from the distribution of the loss suffered in preventing the damage and destruction of war.

Jeremiah Judson Scores One on the Steamfitter

By G. H. Wallace

JERRY, take a couple of men and a couple of jacks and go over to the press room and raise the accumulator of the hydraulic press. The steam fitter will be there to tell you how high to go and what to do," and having thus relieved his mind, "the old man" moved on.

"John, you and Frank get a couple of jacks and go over to the press room and then get a truck load of blocking; I'll be over there in 10 min. ready to look the proposition over," and having also delivered *himself* to a couple of millwrights (?) Jerry moved away.

In due time the gang and the jacks were on the job and Jerry looked the proposition over. "How far have we got to lift it, Nick?" said Jerry to the steamfitter. "Only about 8 in.," said Nick as he put the remains of a package of Peerless back into his pocket.

The jacks were duly arranged under the accumulator that looked innocent and serene in the dark corner with the top hid in the misty haze of darkness and the lower part screened by a camouflage of old dies, scrap and a general miscellaneous aggregation of etcetera.

"All right, men, both together, heave," said Jerry as he gave the two millwrights a good "send off." The slack was taken up and the men began to show signs of disinclination.

"Say, but that's a man's job, or I miss my guess," said John as he wiped his noble brow with a piece of waste.

"Yes, several of them," echoed Frank from the other jack over in the darkness of the back corner.

"Wait till I get a couple more men and jacks; get some more blocking"; and Jerry flew out for the reserves.

In due time, four men were pulling on four jacks with about as much success as Hindenberg had on the West Front. Nothing stirring, a-b-s-o-l-u-t-e-l-y not. "Wait a minute," said Jerry as he beat it for the door, upsetting one of the wop sweepers unconsciously in his flight.

"We've got to have more 'beef' on that job," said Jerry as he came within sight of "the old man." "All right, I'll send you four more men." In about 5 min. 8 husky men were resting 'on their oars' while Jerry looked inquiringly at the size of the accumulator.

"All ready, men, heave 'er," and Jerry started them off. More Hindenburg; the only thing that was different from the efforts of the two and the four men was that the blocking began to crack and one of the jacks showed signs of premature decay.

"Nick, wottinell have they got in that accumulator that we can't raise it?" said Jerry as he stood off and looked about the same as he does when discussing the Kaiser.

"Nothin' but about 40 tons of scrap iron to give the wotter a little pep," said Nick as he spit over the belt.

"Forty tons of iron!" exclaimed Jerry as his Irish began to appear. "What have you got to raise the — thing 8 in. for?"

"To get the end of that inch-and-a-half hydraulic pipe out of the piston where it broke off yistiday and let the 40 tons down like a 40-in. shell hittin' Berlin."

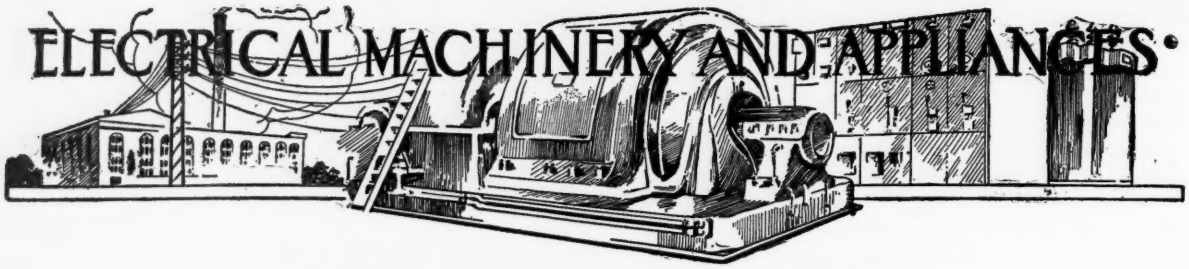
"Is that all?" said Jerry as he grabbed a square drift out of the steam fitter's box with one hand and a 10-lb. sledge with the other and before any one could wink Jerry had driven that drift in with a couple of blows like a howitzer and put the 36-in. "jimmy" on it. "Put your beef on here," said he to Nick, who was closest, and at the second yank, the broken end started. The rest was easy.

"Clear away the wreck," said Jerry none too pleasantly as he went out the door muttering something about "those bonehead steam fitters that were rejected in the draft because they had no brains."

Ships

UNDUE confidence is bad. Undue pessimism is worse. While it took some time to get ways built, and all are not yet completed, results in shipbuilding are beginning to count. The record time for the Tuckahoe and South Pole, speed records for riveting and laying of keels have followed one another fast. Now comes the launching of a destroyer, Ward, in 17½ days from the laying of the keel, and 95 ships launched in a single day, July 4, none of which we held back to swell the number. One of these, a 12,000-t. vessel was built by the Union Plant of the Bethlehem Shipbuilding Co. at San Francisco in 45 calendar days, a record for that size of ship. This plant was awarded first place for steel ship construction in the May contest, second and third places going to Skinner & Eddy Corp. of Seattle and The Moore Shipbuilding Co. of Oakland. For wooden ships, first place went to the Grant Smith-Porter Yard, St. Johns, Ore., second to the Aberdeen, Wash., yard of the same firm, and third to the Allen Shipbuilding Co. of Seattle.

A year ago, our shipbuilding industry was negligible. Now, over half a million men are engaged; 350,000 in the yards and 200,000 in mills and shops turning out parts and machinery. Director General Schwab doesn't like to predict. He points to 263,000 tons of shipping put into commission in May, over 300,000 tons on July 4 and says modestly, "It simply gives a measure of what we hope to do."



Electric Storage Batteries---IV

CARE AND APPLICATION OF BATTERIES

KEEP the level of the electrolyte well above the tops of the plates and when making up for evaporation losses use only pure distilled or clean rain water. Regardless of the condition of charge in which you may think the battery to be, make it a practice to take specific gravity readings at regular intervals.

An increase or a decrease of temperature, while not affecting the strength of the electrolyte, will tend to change its specific gravity and it is for this reason corrections of hydrometer readings are advisable whenever such readings are taken at temperatures other than 70 deg. F.

With an addition of heat, the electrolyte will expand and as a result its specific gravity will lower approximately one point (0.001) for each 3 deg. rise in temperature. On the other hand, a reduction of heat will cause a contraction of the electrolyte and a rise of about one point (0.001) in specific gravity for each 3 deg. fall in temperature. If, for example, an electrolyte has a specific gravity of 1.275 and its temperature is reduced to 64 deg. F., the gravity will accordingly rise two points (0.002) or from 1.275 to 1.277, and as this temperature change in no way affects the strength of the electrolyte, it is necessary that the gravity reading be corrected one point for each 3 deg. change in temperature, from 70 deg., or in this specific instance, two points for the 6 deg. drop in temperature.

For convenience of the storage battery man, a thermometer has been designed on which the amount of correction is indicated. This is on the side opposite the mercury column and parallel to the temperature scale; that is, opposite the temperature 70 deg. F. is figure 0, showing that at that temperature no correction is necessary. At 3 deg. F. below 70 is shown minus 1, indicating that the gravity is to be corrected by deducting one point. Similarly at 3 deg. F. above the 70 mark is shown plus one, which indicates that the gravity at that temperature should be corrected by adding one point to the reading as shown by the hydrometer.

Sediment which accumulates at the bottom of all lead-acid battery jars should never be allowed to reach a height which will bring it into contact with any of the plates and thereby set up a short circuit.

Note the condition of the separators and if any are cracked or broken replace with new ones.

Frequently, due to long continued standing at discharge, which may be brought about by an unnoticed internal short circuit of the cell, the grids of lead batteries are found partially or wholly covered with a light gray deposit of lead sulphate, and as this material is a nonconductor, it is very detrimental to the efficiency of the battery. Whenever such deposits appear, the cell so affected should be subjected to a very long-continued overcharge in order to reduce the sulphate to active material.

The white deposit sometimes found on lead battery plates is often referred to as lead sulphate, which, however, it is not; this white deposit is lead hydrate and may be readily removed by scraping the plate with a light stick of wood.

If the use of a battery is to be entirely discontinued for a period no longer than about nine months, The Electric Storage Battery Co. advises the following procedure: Give an overcharge, just before the idle period, and during this charging period add water to the cells so

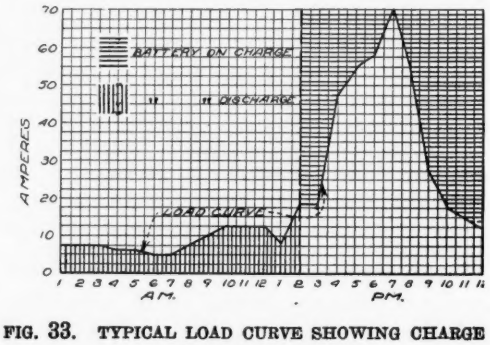


FIG. 33. TYPICAL LOAD CURVE SHOWING CHARGE AND DISCHARGE PERIODS

that the gassing will insure thorough mixing, raising the level of the electrolyte to about ¼ in. below the top of the jars. Though not likely to do so, the level of the electrolyte may, due to excessive evaporation during the idle period, fall below the top of the plates; if this should occur, add water to keep them covered. Should the batteries be subjected to low temperature, stir the electrolyte after adding the water, and in that manner thoroughly mix the electrolyte and thereby prevent freezing.

If the battery is to be out of service for more than nine months give it an overcharge, siphon off the electrolyte (which may be used again) into thoroughly cleaned glass receptacles, and as each cell becomes empty immediately fill it with fresh pure water. When all the cells have been filled with water, allow the battery to stand from 12 to 15 hr. Remove and discard the wood

separators. Next siphon the water out of each cell, after which the battery may be allowed to stand indefinitely.

Should there be a considerable amount of sediment at the bottom of the cells, this should be removed before it dries.

When the battery is to be placed into service again and if the electrolyte has not been withdrawn, all that is necessary is to add water, if needed, to the cells and give an overcharge until the gravity of the electrolyte has ceased rising over a period of 5 hr.

If the battery has been standing without electrolyte, proceed as follows: Equip cells with new separators and fill with either new electrolyte of 1.210 specific gravity or, if the old electrolyte has been saved, add enough new of 1.210 specific gravity to replace loss. Charge for 35 hr. at the normal rate, or for a proportionately longer time at a lower rate.

When fully charged, the positive plate should have a chocolate brown appearance and the negative plate a grayish color.

More or less confusion appears to exist in the minds of many as to when a cell may be actually gassing. Bubbles may rise from the positive plates and not from the negative plates, or from the negatives and not from the positives, which in neither may be referred to as

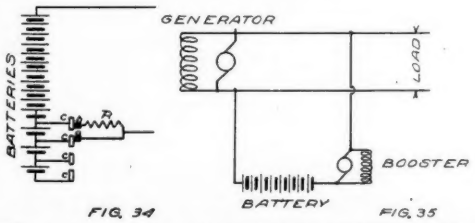


FIG. 34. DIAGRAM OF CONNECTIONS SHOWING END CELL METHOD OF BATTERY CONTROL

FIG. 35. DIAGRAM OF CONNECTIONS SHOWING BOOSTER METHOD OF BATTERY CONTROL

gassing of the cell. It is only when bubbles arise from both plates that gassing may be said to be taking place.

Edison Storage Battery Care

Electrolyte used in the Edison alkaline battery consists of a 21 per cent solution of potash in distilled water and as in the case of the acid battery, the level of the electrolyte should be maintained well above the tops of the plates; evaporation loss must be made up by the addition of distilled water.

Due to the container being made up of a conducting material, the external portions of the cells must be kept clean and dry, and except when adding water, the vent caps must be kept closed.

Due to the radical difference in theory and form of construction employed between the Edison battery and the lead-acid type instructions relative to the care of one would hardly apply to the other, and it is for this reason that the following hints taken from publications of The Edison Storage Battery Co. are given.

Primarily these batteries appear intended for vehicle service and therefore the compartment in which such a battery is installed should be so constructed as to afford ample ventilation during warm weather. Openings for that purpose should be so located as to exclude dirt and water as far as possible and should be so constructed as to allow the closing of these openings during cold weather. While charging always remove battery compartment doors.

To determine the level of the electrolyte, a simple and unique method is advocated by the manufacturers. Secure a piece of glass tubing about 9 or 10 in. in length and with an internal diameter of no less than 3/16 in.; its ends must be straight cut and to one there is attached a short piece of rubber tubing. Insert the tube until the top of the plates are touched; then close the upper end (carrying the rubber tube) with the finger and withdraw the tube. The height of the liquid within the tube indicates the height of the solution above the plates in the cell.

When the solution becomes low, fill to the proper level, using only pure distilled water which has been kept in a closed vessel and in order to do this with the least amount of spillage the use of a special electric filling outfit manufactured by The Edison Electric Storage Battery Co., is recommended.

Because of the false level produced by gassing the battery should never be watered during charge and if a battery is charged by the tapering current method, watering will usually be required about once a week in normal operation.

While charging, always open the compartment in which the battery is installed, so that the gases may be allowed to escape. When the air temperature is high, provide the greatest possible ventilation.

The temperature of the electrolyte in the cells should never exceed 115 deg. F., as excessive temperature on charge will shorten the life of a battery.

When a battery is installed and ready for service, charge it for 12 hr. at the normal rate. Repeat this after 30 days' service and again after 60 days' service. Before starting an overcharge, the battery should be discharged completely and the solution brought to the proper level. Tests of solution height should be made before and after overcharges, but not while the battery is on charge.

Batteries may be charged by either the "constant current" or the "tapering current" method. The constant current method may be employed when an adjustable rheostat is included in the circuit while the latter method may be employed either with an adjustable rheostat or with a fixed resistance of proper design, in the circuit.

The proper length of charge is determined by the extent of the previous discharge.

If totally discharged, recharge the battery at the normal rate for 7 hr. If half discharged, recharge at the normal rate for 3.5 hr. If only one-quarter discharged, recharge at normal rate for 1.75 hr., etc.

If the extent of the previous discharge is unknown, charge at the normal rate until the voltmeter reading has remained constant for 30 min. at about 1.8 per cell, with normal current flowing.

With the constant current method of charging, it will be found necessary to adjust the rheostat every half hour or so to keep the current at the right value. Set the current each time a few amperes high, so that it

will not drop much below normal before the next adjustment.

If necessary, and full capacity is not required, a battery may be taken off charge at any time and used.

Always charge at the normal rate except as provided under "tapering charge" and "boosting."

If the tapering-current method is used, set the rate high enough above normal (about 50 per cent above will be found right in most cases), so that as it decreases, due to the rise of battery voltage, it will average normal, and do not touch the rheostat again until the charge is finished. Charge the same number of hours as if the rate were constant at the normal value. By this method the rate will automatically taper, until at the end of charge it will be considerably below normal.

If the charging equipment includes a fixed resistance especially designed for this method of charging, it is simply necessary to close the switch. If a switch is provided for short-circuiting a portion of the fixed resistance, this should normally be open, but should be closed in case the average value of the current, due to the variations in line voltage, cold weather or other cause, is less than normal.

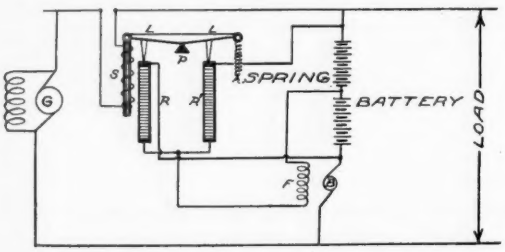


FIG. 36. DIAGRAM OF CONNECTIONS SHOWING USE OF CARBON PILE REGULATOR

Provided the temperature of the solution, in cells near the center of the battery, does not rise above 115 deg. F., the battery may be boosted at high rates during brief periods of idleness, thereby materially adding to the charge. The following table gives figures that may be used under average conditions, but values that will not cause excessive heating must be determined in each case by experience.

5 min. at five times normal rate.
15 min. at four times normal rate.
30 min. at three times normal rate.
60 min. at two times normal rate.

Frothing at the filler opening is an indication that the boosting has been carried too far (if the solution is at the proper height), and the high rate should be discontinued at once.

In time the electrolyte becomes weak, and if when tested after a full charge, its specific gravity is found to be 1.160 or less, the cells should be entirely emptied and refilled with fresh solution. This will usually be required after from eight to ten months of daily service, but the period will be longer or shorter according to the care taken in properly watering and charging.

Before measuring the specific gravity of the solution in a cell, always make sure that it is filled to exactly the proper height; otherwise a misleading reading will be obtained.

The specific gravity of standard renewal solution is about 1.250, but when put into a battery it will quickly fall to normal, due to mixture with the old, weaker solution, remaining in the plates.

No solution other than that put up by the manufacturers of the battery should be used.

Do not pour out the old solution until you have received the new, and never allow cells to stand empty.

When ready to refill, first discharge the battery completely, then remove the old solution. It is best to pour out about half the solution, shake the balance vigorously, and empty. Do not rinse cells with water; use the old solution for this purpose. Then immediately pour in the new solution, using a glass or enameled funnel, or siphon, taking it directly from the drum, by means of a clean rubber tube.

Fill to exactly the proper height.

Do not use the electric filler for refilling cells with solution.

When the new solution is in, and the battery is again connected up for service, give it a 12-hr. charge at the normal rate.

Never put lead battery acid into an Edison battery or use utensils that have been used with acid; you may ruin the battery.

Never bring a lighted match or other open flame near a battery.

Never lay a tool or any piece of metal on a battery.

Always keep the filler caps closed, except when necessary to have them open for filling, as provided in these instructions.

Application of Storage Batteries

Storage batteries are primarily employed in power plants for the purpose of supplying the station output during the hours of small demand, or for equalizing a rapidly fluctuating load such as met in stations furnishing energy to electric railways systems. There are, of course, other uses for storage batteries, such as providing current for the excitation of alternating-current machine fields in case of accident to the main exciters and for the operation of remotely controlled switches and rheostats.

It is in connection with the smaller direct current plant that the storage battery is most extensively employed to care for the station output when the demand is light and while from a theoretical point of view it might appear desirable to use a battery in connection with all stations not at all times loaded to full capacity, such is not always the case in practice. The high initial cost of the installation and the depreciation which frequently is as high as 10 per cent per annum, may many times not be offset by any savings accruing from increased plant efficiency due to the use of such a storage battery. Local conditions must be taken into consideration, and a thorough study of the installation made before steps are taken to add a storage battery plant.

Let us, for example, take the case of a small power plant the generating equipment of which consists of a Diesel oil engine rated at 750 hp. and a direct connected 110-v., 550-kw. generator. The daily load curve of this station, which we may assume furnishes electric light and power to a small village, may be similar to the one shown in Fig. 33. It is quite evident from this that

if 24-hr. service is maintained, the greater portion of the day will find the generating set operating at exceedingly low efficiency and unless during the periods of light load the operator may be employed in doing other work in connection with the system, such as, for instance, repairing and testing electric meters or other devices, his entire time will have to be charged to operation.

If, however, a storage battery of sufficient size is installed, this battery may be made to carry the load with practically no attendance from midnight to 2 o'clock of the following afternoon, after which time the generating set may be started and not only the regular load carried but all surplus capacity available may be used to charge the battery. By the installation of the necessary equipment and its proper manipulation, the load on the engine may be maintained uniform and the generating set operated at its point of greatest efficiency. The section shaded with the vertical lines, Fig. 33, shows the period of discharge while all of that area bounded by the broken line represents the load on the generator while it is in operation, the section shaded with the horizontal lines indicating the amount of energy used for charging purposes.

As the voltage at the end of charge is considerably higher than that at the end of discharge, it is necessary, if the system voltage is to be maintained constant, that a sufficient number of cells be installed to provide such a constant voltage regardless of the state of discharge of the battery, and also to provide means whereby the voltage of the battery at the end of charge may be reduced to conform to that of the line. One of the simplest arrangements for the accomplishment of this is by introduction of a rheostat as shown in Fig. 27. When the load is constant, this method is quite satisfactory; but with a fluctuating load, the rheostat requires constant attention if the voltage is to be maintained as it should.

Voltage Control

For variable load conditions, counter-electromotive force cells in which the voltage loss does not vary greatly with the current, are occasionally employed. These cells are similar to the regular storage battery cell except for the plates which, while of lead, are plain and are not provided with any active material. The voltage drop through the individual cell varies from 2.1 to 2.6 v., according to the value of the current and the excess voltage of a discharging battery is taken up by causing the current to flow through a number of such cells connected in series, the number being reduced as the battery voltage decreases.

By both of the above methods of control, more or less loss occurs and in order to eliminate this, voltage control in the larger installations of storage batteries is accomplished by means of the end-cell system. With this scheme, a number of the end cells are so connected that they may be cut into or out of service as the condition of charge or load may require. The switch used for this purpose, known as the end-cell switch, may be operated manually or automatically.

The diagram of connections for such an arrangement is shown in Fig. 34, which also illustrates the essential features of the end-cell switch. The terminals of the cells are brought out to a series of contacts C, C, C, C, and the movable contact consists of two pieces, a and b, which together bridge across any two adjacent blocks C, C, and in order to prevent an excess flow of current from the cell thus bridged, a resistance R of sufficient capacity to limit the short-circuit current to that equal to the normal discharge current of the cell, is provided.

According to current practice, the maximum voltage of a lead cell is 2.15 v. and the minimum discharge voltage 1.8 v. If, therefore, a battery is to be installed for use in connection with a 220-v. circuit, and the voltage is to be maintained constant, there would have to be installed, with each cell fully charged, 220 divided by 2.15 or 103 cells. But, as the battery is not at all times fully charged, provision must be made to supply 220 v. to the line, even though the cells are nearly discharged and in order to provide this voltage, there will have to be a total of 220 divided by 1.8 or 127 cells, thus allowing 127 — 103, or 24 cells, for voltage control purposes. These 24 cells will then have to be connected in the manner indicated in Fig. 34.

At the end of a charge, 103 cells are cut into circuit; but with the falling off of the line voltage, more cells must be cut in until at the end of discharge the entire bank of 127 cells is in service.

When charging a storage battery used in connection with a power station, it is necessary, especially towards the end of the charging period, to deliver the current to the battery at a voltage somewhat in excess of that carried on the bus bars and distributing circuits. In order to provide this extra voltage, a booster may be connected in series with the battery as shown in Fig. 35.

Frequently, it is desirable to place such boosters under automatic control and an arrangement used extensively for this purpose and known as the automatic carbon rheostat method of control is shown diagrammatically in Fig. 36. Two carbon pile resistances, R and R′ are, as indicated, connected across the terminals of the storage battery, and the field F of booster B is in turn connected between the middle of the battery and the lead joining the two rheostat units. With the device adjusted so that under normal load conditions lever LL is in a neutral position, the resistance of R is equal to that of R′ and as a result no current flows through field winding F of booster B. If, however, the line current drops in value, the pull of solenoid S on the laminated iron plunger is reduced and due to the action of the coil spring, the lower end of lever LL is caused to compress resistance pile R′ and release R with the result that as more current is allowed to flow through R′ and consequently more current also through the field F of booster B, the voltage of the booster is increased and the battery charged. On the other hand, should the system load increase, the pull of solenoid S will cause a greater compression of R, the resistance of which would thereby decrease and a greater current made to flow through field F of booster B in the opposite direction. As a result, the field of the booster is so excited as to cause the battery to discharge.

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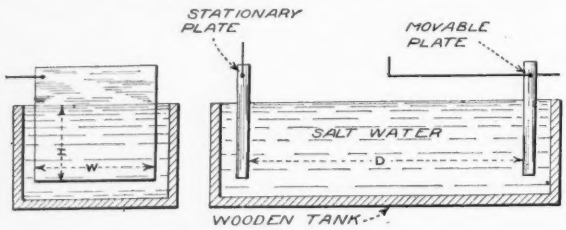
Water Rheostat Resistances

By Carl M. Brooks

IN PRACTICE, it is found that the area of water rheostat plates, in square inches, is approximately equal to the number of amperes the rheostat will handle. For example, the effective area of the plates in the accompanying illustration is equal to the dimension H times the dimension W. With H 20 in. and W 24 in., the rheostat would be capable of handling about 20 times 24 or 480 amp. D, the distance between the plates, determines the amount of energy the rheostat can dissipate. In a general way, about from 2 to 4 w. per cubic inch of volume of liquid between the plates can be dissipated by the average rheostat of the construction shown. A general rule that has been used in some cases is to make the rheostat of such a size that it contains from 500 to 1000 cu. in. of solution per horsepower to be absorbed continuously. It is usually necessary to dissolve a little salt in the solution of a rheostat because pure water is not a good conductor.



ILLUSTRATING WATER RHEOSTAT RESISTANCE

Another type of water rheostat is that in which galvanized iron wire is submerged in a barrel, tank, pool, stream or other volume of water which insures effective radiation of heat. A good working rule to ascertain the diameter, in mils, of the iron wire required to carry a given current is this: Square the current in amperes which is to be carried, extract the cube root of this value and multiply by the constant specified in the following table:

Characteristics of Tank	Constant
Still water in tank or barrel	3.25 to 2.75
Ordinary flowing stream	2.75 to 2.25
Rapidly flowing, low-temperature stream	2.25 to 2.00

TABLE I. RESISTOR CALCULATION CONSTANTS FOR VARIOUS TYPES OF RHEOSTATS

The resistor wire should be wound into spiral coils and mounted on a wooden or insulating frame prior to submersion. One good way to make a rack for this purpose is to build the framework of wood and mount the resistor coils on porcelain knobs. Experience has shown that where the submerged rheostat is contained in a barrel, not over 5 kw. of energy can be dissipated by one barrel. The wire should be submerged at least 3 in. below the surface of the water in a barrel. The length in feet of iron wire required for a submerged rheostat can be calculated by using Ohm's law; that is, by multiplying the e.m.f. in volts to be applied at the terminals of the rheostat by the square of the diameter of the wire in mils and dividing this by the product of the current times 112. Galvanized iron wire has a resistance of 112 ohms per cu. mil foot. The water in which the rheostat is submerged should always be maintained at a temperature lower than the boiling point; that is, it should not exceed a maximum of 212 deg. F. or 100 deg. C.

TABLE II. SAFE CURRENT CARRYING CAPACITIES OF GALVANIZED IRON WIRE FOR SUBMERGED RHEOSTATS

No. B. & S. Gage	Safe Amp. Continuous	Length Needed for Voltages of		
		110	220	500
4	584	66	131	298
5	489	62	124	282
6	412	59	117	266
7	347	55	110	250
8	293	52	103	235
9	245	47	94	214
10	205	45	90	205
11	173	42	84	191
12	145	40	80	182
13	122	38	76	173
14	103	36	72	164
15	88	34	68	155
16	71	32	64	145
17	60	30	60	136
18	50	29	58	132
19	42	27	54	123
20	36	25	50	114

Table II indicates current carrying capacity values for submerged rheostats for continuous use and also shows the length of wire required for 110, 220 and 500 v.

Idle Generator Used to Improve Power Factor

IT IS not unusual to connect a synchronous machine to some part of a circuit to improve the power factor, but a company in New England has found a method of doing this which utilizes any generators that may be idle. This is made possible by the fact that it has duplicate transmission lines running from its main generating station, only one of which is ordinarily required to carry the load. The other circuit is provided for emergency use and also to take care of future increases in load. When the power factor gets low the duplicate lines are parallel at their distant ends, and any generator that may not be carrying load is connected to the reserve line. It is then allowed to run as a synchronous motor, being excited enough to compensate for the low power factor at the delivery end of the line.

A slight load can be put on the generator if necessary to secure the desired wattless current by allowing some water to flow through the waterwheel.

This arrangement, besides utilizing equipment that would otherwise be idle, improves the power factor in both the line and the generators carrying load, whereas if it was merely floated on the bus as a synchronous condenser it would not benefit the line. By so doing it is also possible during a sleet storm to circulate enough current through the reserve line to melt any sleet which may adhere to the conductors.—Electrical World.

Do not expect our men to die for you if you are not worth living for. Show our Army and Navy that you are worthy of protection. Save to the utmost of your ability and buy W. S. S. with your savings.

Power Plant Accidents

HINTS AS TO HOW SOME OF THEM MAY BE AVOIDED. BY JACK L. BALL

IT would require a volume to record accidents and their prevention. By exercising a little precaution, however, the engineer or fireman can perhaps save himself from serious injury, or possible death. When a man is hurt he usually says: "I didn't think," or "I knew no better." There is no excuse for the former; but, to be fair, there might be some excuse for the latter. Our trade journals are excellent guides for the man that does not know; nearly every issue contains some simple directions, or safety first rules, for doing different jobs that incur some danger in their execution.

A few years ago, a night engineer at a coal mine plant had a son who worked in the mine from 7 p.m. to 3 a.m. This son came out of the mine one morning, slipped into the engine room and promptly went to sleep on an 18-in. belt connecting a high-speed engine to a direct-current generator. The father, being unaware that the son was any place but home in bed, started this engine at 5 a.m. It is needless to say that the son was crushed beyond recognition.

Sleeping on belts is a dangerous practice. Enough steam sometimes leaks through a throttle valve to turn an engine over, accumulating sufficient pressure after the throttle has been closed.

DANGEROUS BELTS

THE LACING of a belt from a high-speed engine was ripped about ⅓ of the way across. The oiler complained to the engineer, but was told that the belt was carrying the load all right and to be careful. To fill the oil cups on one side of this engine it was necessary for the oiler to get dangerously close to the belt, which was unguarded. The belt broke and the oiler was frightfully lacerated and bruised. This belt could have been repaired in 10 min. with some of the patent metal belt fasteners on the market.

LAMP EXPLOSIONS

MANY EYES have been blinded by lamp explosions. Always be sure when renewing lamps that the lamp is of proper voltage rating for the circuit. This is easily ascertained, for all incandescent lamps are labeled with the wattage and voltage. In one plant the men make it a practice to break the circuit before inserting a new lamp in a socket. This is a good way, and safe; if, however, impracticable, use a pair of gloves and hold your head down.

If you are testing for an open circuit on a 220, 440 or 660-v. circuit, be sure that you have the required number of lamps connected in series; two, four or six 110-v. lamps respectively are required. I have seen electricians use three, five and seven lamps, and get the desired results.

LEAKING GAGE GLASS

SHOULD a boiler gage glass begin to leak, do not attempt to tighten the packing nuts, especially when under pressure. As the glass ages, it becomes crystallized; this is noticeable where the glass enters the fittings. Usually the least disturbance of the packing nuts results in the glass breaking at the time, or soon after. It is cheaper and safer to insert a new glass, unless the one giving trouble is comparatively new. One of the common causes of gage glass failures is that the fittings are out of line. This results in undue pressure from the packing nuts at one end or both. A good deal of trouble can be saved if a little attention is given to this point. When you have renewed a glass, open the pet cock at the bottom of the water connection, allow some steam to blow through so that when pressure is turned on the hot steam and water will not come in contact with a glass that is cold. Be sure to hold a piece of tin or a small board between yourself and the glass; this may save your eyes.

REMOVING MANHOLE PLATES

WHENEVER you remove the bottom manhead of a highly rated temperature boiler, be sure that it is empty, not partially full of scalding water. Sometimes scale will entirely choke the blowoff pipe and no water will show and no pressure will be indicated by the steam gage. Play safe and use a long board or piece of pipe to push in the manhead.

When you have occasion to remove a top manhead, have the bottom head out, and be sure to have the smoke box doors closed. When the top head is loosened the draft is short-circuited between the two manholes; all danger from being scalded is entirely eliminated. These suggestions apply particularly to boilers that are cooled down and are emptied at once.

REFILLING LUBRICATORS

IT IS STRANGE how many men are burned by hot oil or water flying from a lubricator. Close the feed and the steam valve; be sure to open the drain plug before you take out the filling plug. Any pressure in the lubricator will at once make itself known when you open the drain. When no pressure shows, remove the filling plug.

BROKEN HAMMER HANDLES

IF YOU have a hammer handle that is split or cracked, it is a good idea, if you have not a new handle, to wrap the old one with friction tape. Attention to this may save you a painful injury from splinters entering your hand. If the hammer is loose on the handle, a small iron wedge will perhaps save someone from being hit when it decides to leave the handle.

DANGEROUS CHISELS

BLUNT OR DULL CHISELS have a habit of flying from one's hand when struck a blow. Frayed or burred ends of chisels are dangerous on account of small pieces being broken off and flying, sometimes into someone's eye. An emery wheel and a few minutes of your time will prevent these things occurring.

A CITY IN INDIA wishes to purchase an electrical plant consisting of motors, transformers and other apparatus. Complete information and specifications can be had by applying to the Bureau of Foreign and Domestic Commerce, Washington, D. C., mentioning 27,106.

Fuel Economy in the Boiler Room*

HAND FIRING SOFT COAL. BOILER-ROOM ECONOMY

SPEAKING on the topic, Essentials in Hand Firing Soft Coal, Henry Kreisinger gave as the fundamental, the right proportion of air supply to weight of coal burned. Adjusting of dampers, leveling fire, cleaning out ashes and clinker are all done to secure this result.

Fourteen pounds of air are needed per pound of coal, and must be supplied in direct contact with coal and gases, so as to be readily available for combustion.

In the hand-fired furnace, with fuel bed 5—6 in. thick, only 7 lb. air can come through the fuel bed per 1 lb. of coal burned; hence 7 lb. must be supplied over the fuel bed in some way. Attempt to force more air through the fuel results only in increased rate of combustion, the ratio of air to coal burned remaining constant.

Gases rising from the fuel bed contain 8—10 per cent CO_2, no O and a large current of combustible matter, since the bed acts largely as a gas producer. The 7 lb. of air per pound of coal needed to complete combustion should be supplied in a number of small streams, as close to the top of the bed as possible, so as to mix thoroughly with the combustible. Commonly, it is supplied through the firing door, cracks in the side wall and setting, leaks around the door and holes in the fire.

As coal is fired intermittently at intervals of 2 to 20 min., while air comes in at a uniform rate, it is difficult, in hand firing, to hold the proper proportion of air supply. Ashes are also removed at periods of 3 to 24 hr., thus varying the air supply through the fuel bed.

In the producer action of the bed, carbon is burned to CO_2 in the first 3—4 in. above the grate. The gases take up C in passing through the top layer of the bed and emerge into the furnace, largely as CO. Just after firing, air must be supplied to burn the volatile matter driven off from the coal, as well as the CO from the producer action. After the volatiles are driven off, air is needed only sufficient to burn CO.

This requirement may be approximately met by cracking the firing door a little for a short period after firing.

Extending of distillation of volatile matter may, however, be extended over the entire period between firing, by a coking method, putting a large charge of coal on the front part of the grate, where it is heated slowly until the volatile matter has all been released, when the charge is spread over the grate, and a new charge fired near the firing door. This is feasible for heating boilers, but not for power boilers, as it makes for too great variation in the steam produced.

Shortening the firing period, and firing first one side, then the other of the grate will give even distillation and is better for power boilers than the coking method, but may require firing as frequently as intervals of 2 min. Spread evenly, but cover thin spots well so that holes will not form.

Good results come with a fuel bed 5—6 in. thick. A thick fire calls for heavy draft, which increases air leakage, and tends to form clinkers. A thin bed with frequent firing permits more rapid combustion than a thick bed, and avoids difficulty when the load falls off, as the firing interval can readily be lengthened.

BOILER-ROOM ECONOMY

GEORGE H. DINAN, in speaking on this subject, called attention to the advantage of tactful treatment of the boiler-room force, the advantage of using fewer and better men and paying high wages, to secure intelligent and skillful handling of the fires.

As to settings, he advocated grates not over 7 ft. long, better 6.5 ft., so that the back end may easily be kept well covered. Boilers at least 4 ft., better 5 ft. above the grates to give a large combustion chamber. Free opening for air into the ashpit the full width of the grate.

He would start with a fire 14 in. thick and try to keep that thickness throughout the day's run, firing at frequent, regular intervals and putting on just the right number of shovelfuls each time to keep up the established thickness of fuel bed. Plan so that 5 to 6 shovelfuls will be fired at a time on alternate sides, and the man will have a rest period between firings. Have the man sit down when he is not firing.

Run the boilers at 150 per cent of rating to get a hot fire. Use a good shaking grate to keep the ashes cleaned out of the bottom, and avoid slicing as much as possible. Set the dampers so that all boilers have the same draft in the breeching, and if regulators are used, have them adjusted so that the damper can never be closed tight, as this tends to form CO.

Avoid cleaning fires if possible during working hours, but if it must be done, burn down one side, clean out refuse and ashes thoroughly, throw over the unburned coal from the other side and cover it; when that is burning, clean out the second side and coal up.

Mr. Dinan believes that opening fire doors does not seem to reduce capacity materially, but uneven feeding of water may be a source of much loss. Keep boilers perfectly clean inside and out.

Changes in dimensions of boiler settings were mentioned by C. H. Bromley, such as increase of the height of furnace for B. & W. boilers from 8 ft. a few years ago to 12 to 14 ft. now; and for Stirling boilers from 5.5 ft. to 7.5 ft., or in one recent instance to 11 ft. A table from the Bureau of Mines Bulletin No. 135 for combustion space per square foot of grate area was also given as follows:

COMBUSTION SPACE PER SQ. FT. OF GRATE SURFACE

Lb. Coal Burned Per Sq. Ft. of Grate Per Hr.	Per Cent of Heat Undeveloped During Combustion	Cu. Ft. Combustion Space Per Sq. Ft. Grate Area for Coals Below.		
		Pocahontas	Pittsburgh	Illinois
50	5	2.7	2.9	4.3
	3	3.2	3.7	5.3
	2	3.6	4.4	6.3
	1	4.0	5.6	8.9
	0.5	4.8	6.8	11.9
25	5	2.0	2.2	3.5
	3	2.3	2.7	4.35
	2	2.7	3.1	5.1
	1	3.4	4.0	6.2
	0.5	4.0	5.0	7.1

*Continuation of discussion before the Fuel Session of A. S. M. E. at Worcester, Mass.

Mr. Bromley emphasized also the importance of insuring thorough mixture of air with the volatile gases as being a factor of even greater importance than maintaining extremely high temperature in the combustion chamber.

The Double-Pipe Condenser

SOME HINTS REGARDING ITS CARE. BY A. G. SOLOMON

IF, owing to a freeze-up, the tubes of the double-pipe ammonia condenser have all been removed, the first step in the putting together process is to see that the outer pipes are ready to receive the tubes. Look into the ammonia return bend castings and see that none of the old gaskets are left. Pieces of the old gaskets will interfere with the new gaskets that will have to be put in.

Put back any ammonia return bends that had to be removed on account of bulged inner tubes.

When the inner tubes were taken out the chances are that some of the packing glands were stuck so tight that tubes were removed with a gland left on. There are two ways of taking off stuck glands. First: try heating the gland in fire. Do not get it red, but almost so. Then place the pipe in a vise and tap the gland with a hammer. As a rule, this will loosen the gland and it can be removed without cracking.

Even before the tubes are removed, it often proves advantageous to use a blow torch on glands that are stuck tight. If any glands are found that will not yield to heat treatment, there is another way of removing them. Saw off the tube close to each side of the gland and then with a round nose or diamond point chisel cut out the remaining piece of pipe. Or, if a drill press is handy, the piece may be drilled out.

Extra glands should always be kept on hand, as well as a few of each of the different castings, especially those at such parts as are liable to crack.

Often it is more to the interest of the engineer to save the tube and not the gland. So, if extra glands are kept on hand, and the saving of time is of any consequence, the stuck gland is cracked off and a new one used.

If, upon examination, the inside surfaces of the outer pipes are found to be coated with oil, steam them out clean. To do this, the openings in the ammonia return bends must be blanked off by the use of washers of the same diameter as the outside of the gland. These may, if desired, be made of wood by placing a piece of pine in a lathe and turning it to the proper diameter; then saw in pieces ¾ in. thick. If a lathe is not available, the wood can first be sawed into ¾-in. thicknesses, and the circle marked with a pair of dividers, and then cut out with a knife or chisel.

No gaskets are needed, as the bolts will pull the gland up against the wood and make a good joint.

Then steam is turned into each coil separately, and the oil is blown out. Air must be turned in while the coil is still hot, so as to remove the moisture. After all the coils are clean, the wood washers are removed and the inner tubes slipped into place. The gaskets are then put in, but before doing so, the part of the inner tube that comes in contact with the gaskets and gland should be given a coat of graphite and oil. The glands may then be set up lightly.

The half unions which mate with the water return bends are then put on the ends of the tubes and the return bends put on. As the glands have not been set up tight, the tubes can be slipped either way to allow the return bends to face up square. Use graphite and oil on everything, so that taking apart will be easy the next time. Graphite is about the greatest pipe, fitting and labor saver known, as by its use the pipe and fittings are not damaged when repairs are done.

Every valve on the condenser must be taken apart and put in first class condition. If the valves have been handled roughly and the soft metal discs are pressed out of shape, new discs must be poured. Obtain a ladle and melt enough hard babbit, so the cast disc holder can be covered. This will melt out the old disc. Melt them all out one at a time, and skim the dirt from the top of the hot metal. By removing the old discs in this way, no babbit is wasted. Then heat the cast disc holder and pour the recess full of the hot metal by means of a small hand ladle. Pour full, and, when the disc is cold, enough babbit will be found extending above the casting to enable a good true face to be turned in the lathe.

Next, see that the packing is good and soft enough to allow for tightening up. If not good, remove it and put in new. Be sure that the valve stem is clean and smooth, where it comes in contact with the packing and see that the threads on the bonnet and in the packing nut are in good order. Use graphite and oil on the stem, packing and threads.

When putting the valves together, it is best to put the bonnet in place and shut the valve down tight enough to make a mark on the soft metal disc. Then remove the bonnet and see if the mark is even. If the disc does not seat all around, scrape the high spots and try it again. When the seat is known to be good, a wrench should never be used to close a valve.

After all the valves have been repaired, test the whole condenser with 300 lb. air pressure. If there is a loss of pressure and the leak cannot be found, there is always a chance that one of the inner tubes is bad. The water return bends must then be taken off again. Generally the leak can be located by placing the ear to the end of the tube. For a real close and decisive test of a suspected tube, one end of the tube is capped and a valve made up on the other end. Leave the valve closed for an hour or more; then just crack it. If any air has leaked into the tube, it will be plainly heard escaping through the small opening of the valve.

When the condenser shows tight under the air pressure the air is removed. If there is a vacuum pump or a jet condenser in the plant, there is no need of using the ice machine for doing this.

A precaution well to bear in mind is—be sure that there is absolutely no oil in the oil trap on the discharge line from the ammonia compressor when the 300 lb. air test is put on the condenser. The presence of oil is liable to cause an explosion. Do not attempt to raise the pressure to 300 lb. at one time. Pump up to not more than 100 lb., then shut down and let the compressor

and pipe work cool. After that, raise the pressure 50 lb. at a running and allow the machine to cool off every time it is down. This may seem to be slow and troublesome, but it reduces the danger of explosion, and such explosions are generally costly and may delay the starting of the plant.

The condenser is now ready for the ammonia. Let just a little ammonia into the condenser and go over all the joints and packing boxes and glands with sulphur. If no leaks are found, let the ammonia in gradually and keep looking for leaks till the full pressure is on, and it is known that there are no leaks.

Coal Prices for Colorado, Texas and Tioga Co., Pa.

THE FOLLOWING prices at the mine, which do not include the 45 cents allowance for wage increase under the President's order of Oct. 27, 1917, have been confirmed for Colorado by the Fuel Administration:

Coal mined in the Walsenburg district by the Aztec Coal Mining Co., Caprock Fuel Co., Monument Valley Fuel Co., Caddell & Carlson, Premium Mining Co., Rugby Fuel Co., Gordon Coal Co., Black Canon Coal & Fuel Co., George McNally Coal Co., Black Hawk Coal Co., Ideal Fuel Co., Breen Coal Co. and the Minnequa Coal Co. not to be sold in excess of following prices:

Run of Mine	$2.15
Prepared sizes	4.15
Nut	3.65
Slack or screenings	1.15

Coal mined by the Gibson Lumber & Fuel Co., in the Royal Gorge Mine, Canon City, not to be sold in excess of following prices:

Run of mine	$2.65
Prepared sizes	4.15
Nut	3.65
Slack or screenings	1.40

For Pennsylvania, coal mined by the Fall Brook Co., in Tioga Co.:

Coal mined by the Fall Brook Co., in Tioga Co., not to be sold in excess of following prices:

Run of mine	$2.50
Prepared sizes	2.80
Slack or screenings	2.30

During July these are subject to a reduction of 15 cents a ton; but on Aug. 1 the tabular price will prevail.

For the state of Texas, prices for coal mined and used are as follows:

Bituminous coal mined in the counties of Arath, Palo Pinto and Young may be sold at prices not to exceed f.o.b. cars at the mine, $3.40 per net ton for run of mine, $4.20 per net ton for prepared sizes, $2.25 per net ton for slack or screenings, subject to the following reductions: 30 cents for the month of July, 15 cents for the month of August.

All bituminous coal mined in the state of Texas, except that produced in the counties of Arath, Palo Pinto and Young, may be sold at prices not to exceed, f.o.b. cars at the mine, $4.25 per net ton for run of mine, $5.05 per net ton for prepared sizes, $2.25 per net ton for slack or screenings, subject to the following summer reductions: 30 cents for the month of July, 15 cents for the month of August.

Lignite coal mined in the state of Texas may be sold at prices not to exceed, f.o.b. cars at the mine, $1.55 per net ton for run of mine, $1.75 per net ton for prepared sizes, $1 per net ton for slack or screenings.

To all prices herein stated may be added the 45 cents allowance for wage increase, if the producing companies are entitled to add such allowance under the President's order of Oct. 27, 1917.

Impurities in Coal

IN a discussion before the A. S. M. E., Albert A. Cary summarizes the effects of excess impurities in coal as: Reduction of heat value per pound of fuel, and of percentage of combustible available, because more of the combustible will be carried away with the refuse.

Reduction of fuel burning capacity of the furnace from accumulation of ashes, with accompanying reduction of furnace efficiency and boiler capacity.

Higher blast pressure needed for forced blast furnaces, due to the dirtier fire bed, which produces greater tendency to holes in the fire and air leakage.

More labor in handling fuel and ashes and in cleaning the fires, and for mechanical stokers, reduced capacity and greater attention and upkeep expense.

Investigation of the impurities in coal during the better part of 1917 showed that some 30 per cent of the car capacity engaged in hauling coal was taken up by the refuse shipped with the coal from the mines.

Besides this, the excess of impurities apparently was the cause of a great number of fires from spontaneous combustion in the bins and storage piles. Plants that formerly stored for years without difficulty found it impossible to store two weeks without having fires break out.

This results in a coking effect, which wastes the valuable volatile constituents and further reduces the heating value of the fuel.

As to the use of fuel with 40 per cent refuse, that depends on whether "refuse" means incombustible matter or the material which actually goes to the ash pit. If 40 per cent of the fuel is incombustible, it is doubtful if a boiler could be operated with such stuff, but if 40 per cent refuse means the pure ash with accompanying combustible that is rejected by the furnace, such fuel has been used during the past winter in a plant having five 400-hp. boilers with ratio of heating surface to grate of 49 to 1. A blast of 1.25 in. of water was carried, and the boilers developed 70 to 75 per cent rating.

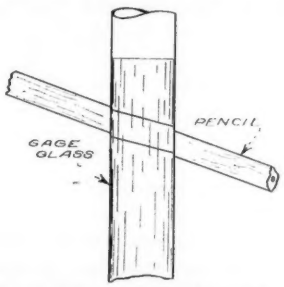
Lightless Nights for August

IT IS reliably reported that the Fuel Administration will order four lightless nights during August, probably along the same lines as those ordered during last winter. Presumably, this will be one night each week, but the day is not yet stated.

Gage Glasses

FREQUENTLY it is difficult to ascertain whether or not there is water in the gage glass of a tank or other vessel, especially when the water line is above the upper gage fitting and the entire glass is filled with water. At these times, it is difficult to determine definitely whether the gage is filled with water or is entirely empty.

A simple and positive method is illustrated herewith. If a rod, stick of wood, or a lead pencil is held at an oblique angle behind an empty gage glass the ordinary shape of the pencil is visible. When the glass is filled with water, however, the refraction of the light deflects the pencil off its true direction as illustrated in the sketch. Consequently, when a pencil held behind a gage



EFFECT SECURED BY HOLDING PENCIL BACK OF GAGE GLASS CONTAINING WATER

glass shows in the manner indicated, it is safe to assume that water is contained in it. When the pencil appears in a straight line, the glass is empty.

This method can be readily checked up and is well to keep in mind for future use. M. A. SALLER.

Hiring and Holding Men

IN LOOKING through issue of May 1 I have come across J. O. Benefiel's article on page 383, under caption "Hiring and Holding Men."

As I have been hiring, though not always holding, men for several years, perhaps my ideas may assist or amuse others. To begin with, I have had men that were excellent operators, but entirely useless as repair men, and also I have had repair men that were top-notchers, but worthless as operators.

An operating engineer may or he may not have the faculty for diagnosing different ailments in the machinery which he is handling, but he also may have the nice sense of feeling and be able to know when a bearing is nearing the danger zone and to get another unit on the board without interrupting service. He may not be able to use a micrometer with the same accuracy as the repair man, but he may be a better judge as to adjusting the receiver pressure.

I have had perhaps five men who could take a shift and carry it through successfully and could also re-tube a boiler or pull an engine down.

Bear in mind I am not speaking of a plant of 500 or 1000 hp., but of a plant generating thousands of horsepower.

The point regarding the way the concern treats its men is mighty well taken. It is hard for an engineer to hold his men, if the other plant in the town pays more money for shorter hours. But then again, if the other chief is a crab or unsuccessful with his help, men may prefer to work for a good man at less wages.

I started a man in the business some years ago who could not add a column of figures correctly; his schooling had been neglected.

He is chief in a plant today—thanks to me?—no—to himself.

He had the brains, but they were not developed, and just a word or two was necessary to work wonders. I will not allow anybody else to give any of my men orders. The superintendent in one plant attempted to give a man orders and he referred him to me in a very saucy way, suggesting that I was his (the man's) boss and that he didn't have to take orders from anybody else. He told the superintendent these facts in a way that the editor would refuse to print and it really was too bad, but I discharged him on the spot. I will not stand for my employes abusing anybody on the premises, and I positively will not have anyone on the said premises abuse them.

Any man in my employ has the right to come to me and ask questions. This courtesy has kept help for me. Also any man from the first assistant engineer to the ash handler has the right (and I want it exercised) to speak or bow to me on the street whether he is in a dress suit or overalls. You may think that this is superfluous, but I can name chief after chief who will absolutely not bow or speak to his men on the street, and, by the way, most of them are in charge of plants in the hundreds instead of in the thousands of horsepower.

If we believe in the Good Book, all mortals are dust; then why not blow about a bit and let the other fellow do likewise?

Now, just a little on discipline in the power plant. I was asked a short time ago if I bawled out the men—meaning, did I correct them in public? No! I have a method all my own for governing the men who might stray from the fold. One day, while examining a pump, I overheard this conversation:

"Say, Eddie, the new chief is dead easy. Don't you think for a minute that I'm going to tear my shirt for him."

And the answer came: "Good for you, George. The

whole station is wise and I'll bet he gets sick of his job."

Did I step out from behind the pump and denounce the two and then read the riot act to the whole station? I did not! I simply sat down at my desk in the corner of the station and wrote the following on a pad, leaving it in a conspicuous corner of the desk:

"The work of the whole station is lessened by every man doing his share voluntarily. Most men prefer to be directed by kindness rather than by violence. If your chief is easy, don't shirk! Remember, that he has eyes and ears and also remember that he did not become chief through inheritance BUT by work."

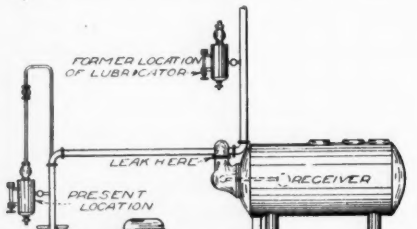
This episode happened some time ago and, up to date, the medicine has not had to be repeated.

No doubt when I went out of the station every man on the watch read the message, though it was addressed to no one and was not signed by TOM THUMB.

Eliminating Oil Trouble in Boilers

WE HAD been experiencing trouble with cylinder oil in our boilers and were at a loss to discover where it came from until we noticed oil around the valve controlled by the float in the receiver.

Although I formerly filled the lubricator three times a week the pump would groan, but now, after changing its location, I fill it only once a week and secure good results and get no oil in the boilers. As will be noted



FORMER AND PRESENT LOCATION OF LUBRICATOR

in the sketch, the steam connection to the receiver was taken from the pipe between the lubricator and the pump; with the new location the oil fed almost directly into the pump.

You cannot always tell by the gage glass when oil is in the receiver. I found a good scheme is to dip a can down through the handhole. If there is oil on the surface the can will skim it off and it will show in the can if allowed to settle for a time. F. J. KNOWLES.

Unusual Cases of Pounding

THREE peculiar cases of pounding have come to my notice in engines of different types, and in each case the pound was not in the same place, but all from the same cause. In the first case a Brown engine was running in parallel with an Atlas. The Brown engine developed a slight pound which could not be located, but strange to say, after shutting it down, the pound seemed to continue about twice as often as when it was running, which made it appear as though it was in, or caused by the Atlas engine running twice as fast. It was found that the exhaust from the Atlas acted on the piston of the Brown, causing it to pound because there was some play in the crosshead boxes, but while the Brown was running, the pound was half as fast, or in unison with the motion of the Brown engine piston.

In another case, two high speed engines running together acted the same way. One started to pound, and after stopping it continued pounding lightly, and it was found that the piston was a little loose, causing it to rattle on the rod when the engine was running, also when the other engine exhausted against it.

The next case is that of three high-speed engines of standard reputation, one of which developed a pound which continued after stopping, and, paradoxical as it may seem, this was caused by the piston rod, which was screwed in the crosshead, actually having play enough in this screw thread with locknut loose, to chuck back and forth, caused by exhaust from the other engines. These engines were all equipped with Tripp metallic packing, which, of course, offered no frictional resistance to the rod; had they been packed with ordinary stuffing box packings the trouble would have kept us guessing, if not worse. A. C. WALDRON.

Hot Water Heaters

IN THE June 15 issue of Power Plant Engineering is an article headed "Hot Water Service," by M. W. Ehrlich, which contains several incorrect statements to which attention should be called.

In the first place, the choice of the type of heater with steam tube or water is not, and should not be, a question of back pressure, because properly designed heaters do not produce back pressure.

In the second place, the question of velocity of the water is disregarded, regardless of the fact that all careful investigators have determined that this is the one governing feature, the rate of heat transmission being a function of the velocity.

The third error is the assumption that tubes made of different metals have different rates of heat transmission. While this is true to a small degree, it should be obvious that the rate of heat transmission through any metal is so much greater than the rate of heat transmission from the metal to the liquid that it has no appreciable effect on the rate of heat transmission, and the factors which he gives in his article are therefore wrong.

Another error is in the example of calculating the number of square feet required to heat water from 40 deg. to 212 deg. with steam at 212 deg. This is an error, as it is impossible to heat water to the temperature of the steam. About the best that can be done in ordinary practice is to heat the water to within 5 or 6 deg. of the steam temperature.

Another incorrect statement is the determination of the mean temperature difference. This is not an arithmetical mean but a logarithmic mean, the formula for which has been worked out a number of times and is

$$M = \frac{F - I}{\log_e \left(\frac{S - I}{S - F} \right)}$$

where I is the initial temperature of the water, F the final temperature and S the temperature of the steam. This formula, applied to Mr. Ehrlich's problem, would give a value for M of O, which is correct, since it would

require an infinite amount of heating surface to heat the water to the same temperature as the steam. On the other hand, if the water was heated from 40 to 210 deg., with steam at 212 deg., instead of having a mean temperature of 87, which is the arithmetical mean, the actual mean temperature difference is 39 deg., so that the area required to heat the water to 210 deg. would be more than double that given in the article.

There is nothing new about the design of this class of apparatus. A careful investigator can find a number of articles in the Journals of the American Society of Mechanical Engineers and the American Society of Naval Engineers. The problems involved are not usually very complicated and can be solved by competent engineers, but they are no more capable of being solved by the ordinary layman than is the problem of the proper design of the steam engine or turbine.

One more point, the Department of Steam Engineering in the U. S. Navy designs its feed water heaters with brass tubes and a coefficient of transmission of 1000, and this design is based not on any haphazard guess but on data gained from numerous tests. It is perhaps interesting to note that recently in the U. S. Testing Station at Annapolis tests were conducted on a heater of standard design where a rate of heat transmission as high as 1810 was obtained, which is at wide variance with the values given in the article mentioned.

OSCAR J. WEST.

Blowing Down Boilers

I READ recently the advice from engineers about blowing down boilers, and there was quite an assortment of ideas.

Now, when a plant is shut down at the noon hour and the fires partly banked, and the water is not agitated but the mud and all the foreign matter has had a chance to settle to the bottom of the boiler just before starting up the fires again for the afternoon run, that is the time, in my opinion, to open the blowoff valve; for as soon as the blowoff is opened, a circulation is started and the circulation will start where the hottest part is, which is the crown sheet right along the bottom of the boiler. When a circulation is started, it is, in my opinion, the natural thing for the mud and sediment that has settled on the bottom to start on a journey for the blowoff; but if the boilers are not partly banked, I fail to see how much foreign matter can be blown off, except in the immediate vicinity of the blowoff, by opening the blowoff while the boilers are working and the water is in circulation.

A short time ago I was running nights, and one morning I was requested to visit a plant near the one where I was employed. I found that the regular engineer was on his vacation. The engine was a single eccentric Corliss and when the spare man tried to start her up she would go about one-half stroke and stop. In looking her over, I found that the engineer, in warming her up before starting for the day's run, had unhooked the eccentric rod from the rocker and in moving the rocker back and forth he had moved it so far on the crank end that he had let the exhaust valve crank drop down so that the exhaust valve was just opposite to what it should be and when the valve should be open to let the exhaust steam out, it was shut and it held the steam in the cylinder so the piston had the back pressure to buck, which was too much.

I unhooked the eccentric rod from the rocker, threw the rocker far enough to allow me to place the valve crank in an upright position, hooked the eccentric rod on the rocker, gave her the steam and away she went.

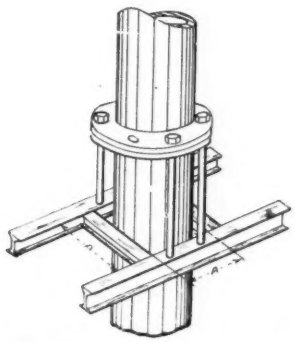
On another occasion, I was sent by the chief to the pump that was used for pumping water for washing purposes and was in the boiler room. The pump was a duplex and one piston rod stuck on the water end and had to be started with a bar. On looking it over, I found that it had been leaking water badly at every stroke and one of the firemen had tightened the stuffing box so tightly and the rod was worn so badly that when it got to the end of the stroke, the rod, not being worn so badly as the end, stuck. I shut it down, dug out the old packing, packed it with new packing, started her up and had no more trouble with her.

H. ARMSTRONG.

Readily Made Pipe Support

PLACING a 15-ft. length of 24-in. piping over a well opening is no small job, especially when only limited clearances exist.

Recently I was required to do this, and in order to accomplish the desired result, we obtained four pieces of 6-in. I beams, two of sufficient length to span the well opening with the other two of such length as readily to tie together the former in the manner indicated by the accompanying sketch. The short pieces were bolted to



METHOD OF SUPPORTING PIPE BY MEANS OF STUD BOLTS RESTING ON I BEAMS

the long ones through the medium of clip angles and when the assembly was completed, the distance A was greater than the width of the pipe by 1 in.

Held in place by top and bottom holding nuts four long equally spaced stud bolts each passed through a regular bolt hole of the flange and resting on the steel work served as supports for the pipe.

With this scheme, adjustments to prevent distortion of the line could readily be made.

DEAN B. COBB.

Correction Note

ATTENTION has been called to a typesetter's omission on page 508 of the June 15 issue. In the twentieth line of Mr. Waldron's letter after the word "is" insert "8.28, giving."

Note Book Kinks

ACCOMPANYING are a few sketches taken from my note book and which may be not only of interest but also of value to the readers of Power Plant Engineering.

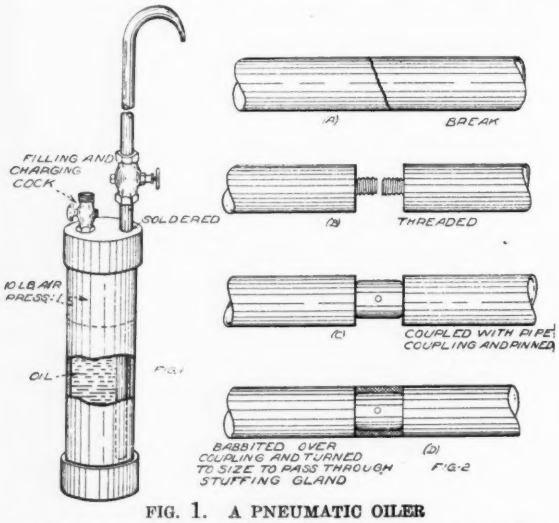


FIG. 1. A PNEUMATIC OILER

FIG. 2. METHOD EMPLOYED FOR TEMPORARY REPAIR TO PUMP ROD

That shown in Fig. 1 is a portable pneumatic oiler and hardly requires any explanation. The body, which is made up of a short length of large size pipe with a cap at each end, is nearly filled with oil after which air at

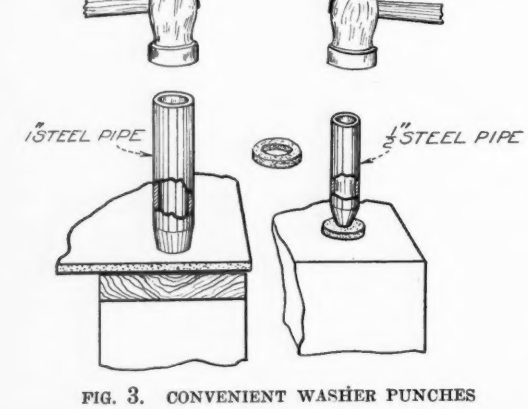


FIG. 3. CONVENIENT WASHER PUNCHES

a pressure of 10 lb. is introduced and the filling and charging cock closed. A slight pressure of the hand or a finger against the button on the stem of the spring loaded valve attached to the spout as shown allows the discharge of the desired quantity of oil.

Some time ago, the rod on a pump broke in the manner indicated at A, Fig. 1. In order to make the necessary repairs as quickly as possible the broken members were turned down and threaded (B) and joined by

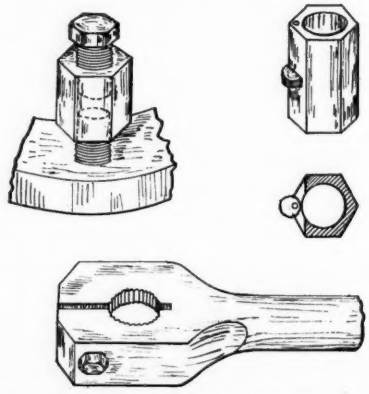


FIG. 4. CONVENIENT STUD WRENCHES

means of a pipe coupling (C). Babbit was then poured over and around the joint which was then turned down to a size corresponding to that of the rod.

The construction and use of the washer punches and stud wrenches pictured in Figs. 3 and 4, respectively, are self-explanatory. C. H. WILLEY.

Boiler Room Improvements

I SUBMIT two ideas that I introduced for the benefit of my firemen. The ashes in cleaning the fires had to

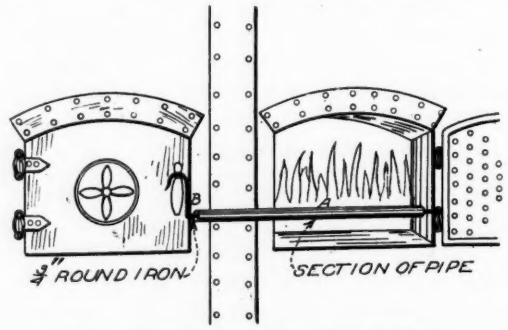


FIG. 1. METHOD OF USING THE LAZY BAR

be drawn from fire doors, owing to the grates being stationary.

In Fig. 1 is shown what I term a "lazy bar," one end being hooked so as to rest on the handle of the closed

door and the other straight to slide easily between the hinges of the other door. A 1-in. pipe length was placed on bar so as to give a better sliding service to the slice bar, hook and scraper.

The other improvement was a tee bar. Much dust was eliminated through its use. A ¾-in. pipe of length sufficient to extend to within 2 ft. of bridge wall and still leave ample room for leverage, was used. At one

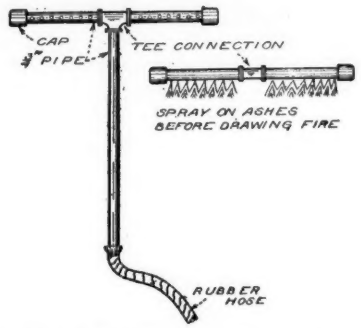


FIG. 2. T BAR USED FOR WETTING ASHES

end was the connection of an ordinary hose pipe so that any section of gum hose could be easily attached. The other end consisted of a cross pipe perforated with ¼-in. holes and having a cap at each end. When water was turned in the pipe after the fires had been pushed back to the bridge wall, a series of small spurts played on the dying embers, wetting them sufficiently so that ashes could be withdrawn and no dust or smoke was seen.

LESLIE C. MILLER.

A Handy Tap Wrench, a Pipe Roller and an Emery Wheel

ALTHOUGH I am but a young man with a few months' experience in a small machine shop, I believe some of the older readers of Power Plant Engineering will be interested in the following descriptions of devices I have seen and worked with.

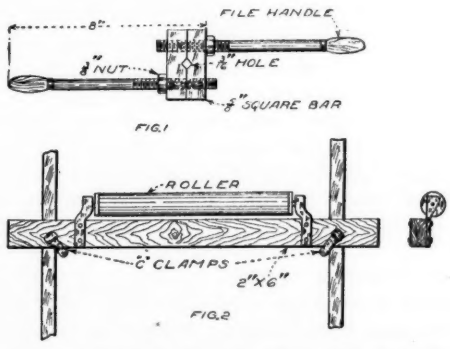


FIG. 1. A READILY CONSTRUCTED TAP WRENCH
FIG. 2. HANDLING PIPING WILL BE GREATLY FACILITATED BY THE USE OF THIS ARRANGEMENT

In Fig. 1 is shown a tap wrench made up of an ordinary steel bar and two pieces of steel rod which act as studs and are fitted with handles for manipulation. When working this wrench, it is important that the square members which hold the tap are kept parallel so as not to strain them non-uniformly.

Recently, I saw the arrangement shown in Fig. 2 used in unloading lumber from a box car, and it occurred to me that this same thing might be instrumental in the saving of "elbow grease" when handling piping under like conditions.

Any mechanic or engineer having available an old lawn mower can readily use parts of this, some pipe fittings and a wheel to construct a satisfactory and reliable high-speed, hand-operated emery wheel. The pinion, meshing with the gear on the inside of the mower wheel,

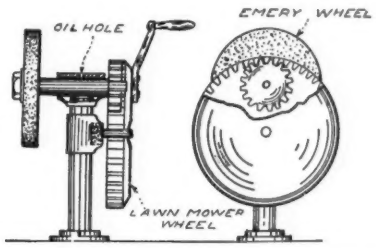


FIG. 3. THE LAWN MOWER EMERY WHEEL

is fitted to a steel shaft shouldered at each end and threaded at the opposite end so as to receive the holding nut for the emery wheel washers.

The standard was built up of a piece of pipe and suitable fittings, and the tee used for the bearings was babbited for the shaft in the usual manner and oil holes provided. The support was riveted at the joints.

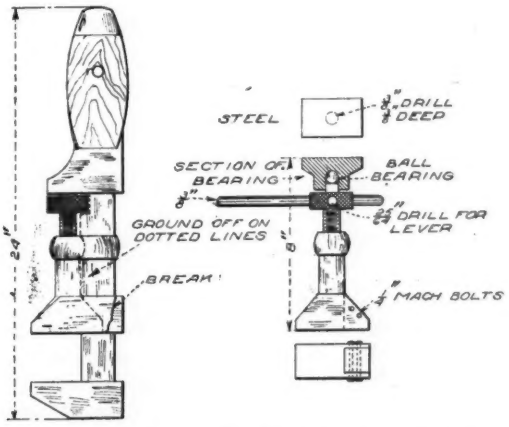
A crank handle riveted to the mower wheel serves as a means to operate.

A BEGINNER.

Novel Jackscrew

SHOWN HEREWITH is a sketch of a "jack," made from a broken monkey wrench.

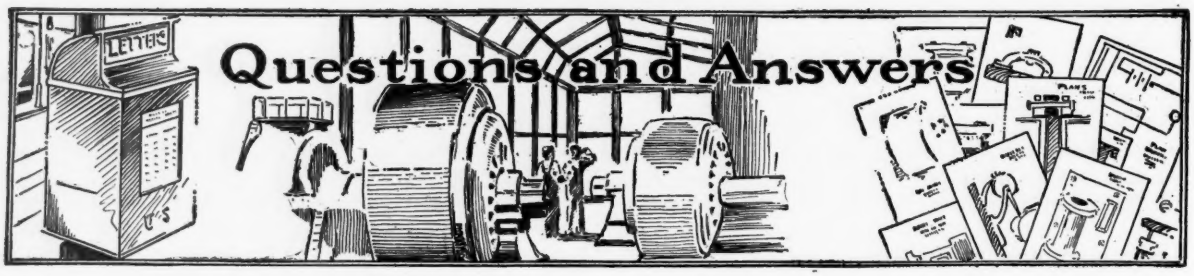
Owing to the fact that one of the straps on the back of the jaw had been broken, the wrench was thrown



DETAILS OF JACKSCREW CONSTRUCTION

into the junk heap. As the screw was in good condition, however, I constructed this little jack and its value on numerous small jobs is surprising. The accompanying sketch will furnish about all the required detail.

JOHN J. DINNEEN.



Reversing Engine Operation

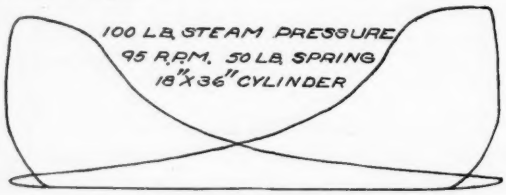
How is reversing accomplished on a duplex steam engine equipped with an eccentric for each cylinder and having cranks spaced 90 deg.? When the throttle is moved one way, the engine runs in a given direction and with a reversal of the throttle the direction of rotation of the engine is reversed.

Will some of the readers of Power Plant Engineering kindly tell me how the valves are ported and how the steam travels through the valves in order to reverse the engine?

The so-called throttle reverse valve to which I have reference is used largely on steam shovels. F. H.

Indicator Card for Criticism

Shown herewith is an indicator card taken from an 18 by 36-in. Hamilton Corliss engine running at a speed of 95 r.p.m.



CARD TAKEN FROM 18 BY 36-IN. HAMILTON CORLISS ENGINE

What suggestions for improvement can the readers of Power Plant Engineering offer? E. N.

Natural Gas for Fuel

Will you please give me some information relative to the use of natural gas under steam boilers?

J. H. B.

A. Information available on burning of natural gas under boilers is not very complete, as this method of generating steam is, as you know, a proposition which applies to only a comparatively small part of the country.

The best practice, so far as we can find out, is, first, to have a burner which gives a rotary jet, in order to mix thoroughly the gas and air as it leaves the burner. The burner should be set so as to avoid the direct flame striking the tubes. This is usually accomplished by putting a brick arch above the burner, extending out some 18 in. to 2 ft. beyond the end of the burner. The burner is set so that the flame goes towards an enlarging combustion space.

If the boiler is like the Stirling, the jet is set at the front end and arranged to discharge towards the boiler —a checkerwork bridge wall being installed at some 4 ft. from the jet. The grate is covered with fire-brick, the back half being laid close, and the brick under the jet, in a fan-shape, being laid with air spaces running from 7/8 in. directly under the burner to about 3/8 in. at the end of the fan-shaped space. Outside this fan-shaped section, the furnace on the front half of the grate has an air space of 1/8 in. between bricks and a space of 5/8 in. is left all around the side walls.

For a boiler like the Babcock & Wilcox, the burner is better set at the back end of the furnace, discharging towards the front, with a checkerwork at about 4 ft. in front of the jet, and baffle brick extending on the undersides of the tubes to some 2 ft. in front of the jet. A combustion space should be provided, 3/4 of a cubic foot per rated horsepower.

Tests on boilers fired with natural gas have shown that at 140 lb. pressure, with feed water 116 deg. F., a gas pressure of 8 oz., and a draft in the base of the stack of 0.35 in. of water, the flue gas temperature shows 417 deg.; the evaporation, actual, is 0.78 lb. of water per cubic foot of gas, and the equivalent from and at 212 deg. F. is 0.895 lb. of water per cubic foot of gas.

Coal Storage Difficulties

We have an open coal storage pile with a capacity of about 10,000 tons. Recently we were called upon to draw from this pile and noticed that at some points the temperature was so high that it was necessary for the men to stand on boards. Do you know of any practical method of keeping down this temperature without resorting to submerging the coal in water, which is impractical in this case? Is there any way of rejuvenating coal which has been stored in the open? H. W. M.

A. The fact that at some points of your coal storage pile the temperature has risen to the degree that you mention would indicate that the pile should be moved. The difficulty in the storage of coal is usually that, if it is dumped from a car, there will be a tendency for the large chunks to separate by themselves, causing flues which will let the air draw up through the pile. Then, the fine dust will be spilt up into a powder, which, because of the packing together and the influx of the air in small quantities, will heat, disintegrate and eventually be likely to ignite from spontaneous combustion. When this happens, there is only one thing to do—that is, to go into the spots that are heated with a big clam shell, or other device, and take out those hot spots.

I would advise you to get from the Engineering Experiment Station of the University of Illinois, at Champaign, Ill., Prof. Stoek's book on the "Storage of Coal," which is the most complete treatment that has yet

been published, and gives full information on the experience of a great many companies throughout the country on the storage of coal; the conditions necessary to do this satisfactorily, and how to handle the situation when a coal pile heats.

To prevent the rise in temperature, Prof. Stoek states that one of two things must be done; either there must be a large number of flues provided so that there will be a great amount of air flowing up through the pile, and the flues ventilated satisfactorily to carry off the heat, or else the pile must be closed in at the sides and bottom so that no air can get in. This last is, of course, out of the question for large amounts such as you are storing. The method of avoiding spontaneous combustion from the dust is to use sized coal and keep all fine stuff out of the heap. It is the dust that causes the spontaneous combustion.

As to rejuvenating the coal, there is no method of doing this. Tests have shown that the amount of heat value lost is comparatively small. The coal that has been stored does not burn quite as readily as coal fresh from the mine; but except where the temperature has risen to such a point that a partial coking process has taken place, and some of the volatile matter been driven off, the loss from weathering in storage is but slight. There is, however, no way to take care of this loss.

Steam Consumption of Heating System

DURING LAST SUMMER, in an endeavor to reduce what we thought was an excess consumption of low-pressure steam for heating, we made some alterations in our heating plant that have shown considerable saving during the past 6 mo. of the heating season; however, the mean temperatures for the months of October, November, December and January have been considerably lower than for the same months of last season and we feel that we should credit ourselves with a theoretical increase in consumption to offset these lower temperatures this season.

We have already made some figures and arrived at what we believe is a reasonable percentage of credit; but to check ourselves up in the matter, we would like to have all the additional data that we can possibly get.

Have you ever had a parallel case and can you give us any rule on which to base this percentage of increase?

As a concrete example, during the month of January, 1917, we used 16,133,752 lb. of low-pressure steam and the outside steam temperature for the month was 27.3 deg. F. above zero. In January, 1918, we used 15,583,769 lb. of low-pressure steam and the outside steam temperature was 15 deg. F. above zero. You will note that this gives us a mean temperature for the month of 12.3 deg. lower this year than last.

Also note that we used 529.983 lb. less this year. Of course, we really would have used more steam this year than last if we had continued operating the old system without having made any alteration. J. G. M.

A. In regard to the steam consumption in your heating system, the radiation of heat will be proportional to the temperature difference between the inside and outside temperatures.

Assuming the inside at 70, the difference in 1917 will be 42.7 deg.; in 1918, 55 deg., for the January period.

The amount of steam that you would have used in 1918 without change in your system would then be found by multiplying the 1917 consumption by 55 and dividing by 42.7. This gives about 20,781,000 lb., and subtracting from this the amount actually used in 1918 gives a saving of approximately 4,997,000 lb.

Balancing Steam Engines

HOW MAY ONE best balance a steam engine of the reciprocating type? R. D. B.

A. The question of balancing an engine is rather an intricate one. You know, of course, that the vibration comes from the stopping of the reciprocating parts, the piston, piston rod, crosshead and connecting rod—and their reversal at the end of the stroke.

There are two forces that have to be counteracted, the horizontal force of inertia of these parts, and the vertical force of inertia of the connecting rod swinging up and down. The horizontal force can only be counteracted by a heavy weight on the crank disk or a fan-tail weight opposite the crank, of sufficient size to balance, by its centrifugal force on the horizontal centers, the force of inertia of the reciprocating parts. If the counterweight is made heavy enough to do this, it will overbalance the vertical force of the connecting rod on the top and bottom points, and will, therefore, tend to make the shaft jump up and down in the bearings.

It is usually necessary to effect a compromise, having the weight of such size as to counterbalance the horizontal force in part, and yet not overbalance the vertical force too much. The foundation of the engine must take up the unbalanced force which cannot be handled by the counterweight.

Another thing which can be done to stop the reciprocating parts is to use a higher compression at the ends of the stroke. This cuts down on the amount of power that the engine can deliver, but tends to prevent the inertia shock on the shaft, transferring it, however, to the cylinder heads.

If the engine is mounted on a single cast-iron base, the vibration is due, of course, to a moving of this base on the foundation, or to the movement of the base and foundation together, and in this case, there is almost no possibility of doing anything with it except to put a big chunk of concrete around the whole base, making sure that it bonds well into the present foundation, and take up the vibration in that way.

There is no book on this subject that we know of, and such treatment of the balancing of engines as is found in books devoted to engine design and construction is rather complex and mathematical, intended more particularly for designers of engines.

Acetylene Welding Problem

I READ Mr. Haeussers' letter on page 209 of the March 1 issue, and it is my opinion that the flame was too rich in acetylene and carbonized his welds. I think he will have better success with hydrogen, when his work is not too large. I do not agree with Mr. Notthoff, page 338 of the April 15 issue, as to the flux he uses. In this neighborhood, it is generally thought best to keep away from carbonates. We think a better flux consists of 30 per cent sodium chloride, 65 per cent borax and 5 per cent red oxide of iron. F. W. ARCHBALD.

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Safeguarding Your Plant

In these days, when every ounce of energy of every ablebodied man, and every pound of product of our industrial plants, is needed to further the success of our forces and win the war, it is important that no precaution be omitted to safeguard against accidents which may decrease man power or plant power. Safety, first, last and in between, should be the watchword of the man who is responsible for men and equipment.

Injury to men is largely a matter of providing every possible safeguard and establishing rules that these must not be removed. Then enforcing the rules, and educating the men to understand that the precautions are for their safety as well as in the interests of the country.

In 1916, about 22,000 persons were killed in industrial accidents in this country and 500,000 injured so as to be unable to work for 4 weeks or more. Assuming that 20 per cent of the accidents were unavoidable, this gives 17,600 needlessly killed and 400,000 needlessly removed for a month each from industry, to say nothing of the suffering and expense entailed.

While the first care of the engineer should be to see that safety is ensured in his own domain by guarding belts, wheels, gears, shafting, rods and stairways, it is good policy to watch for danger points throughout the factory and recommend preventive action both as a matter of humanity and in the employer's interest. In a quiet way, he may well act as a safety inspector, watching equipment and practice, for dangerous habits are easily formed and dangerous conditions neglected by those who from daily contact have grown careless of the danger. A life or a limb saved by the engineer's watchfulness and thoughtfulness will be ample reward for much effort.

One source of loss for which Americans are much to blame is fire. Our record in that respect can hardly be excused, for each day sees an average of 1500 fires, most of which are preventable. Carelessness of smokers is charged with a loss of $165,000 a week and much loss of life; rubbish, including piles of waste wood, oily rags, etc., are a menace that should not be allowed to exist. The engineer may well be a means of helping to remove this danger in the plants of the country, as well as making certain that the apparatus for fighting fire, which is usually under his charge, is as complete as possible and at all times ready for instant use. One thing which will help is the education of children as to the fire danger, and arousing their interest in removing dangerous conditions. A booklet, "Safeguarding the Home Against Fire," has been prepared by the National Board of Fire Underwriters, and is in a fair way to be adopted for use in the public schools. Circulation of copies, which may be obtained from the Board, 76 William St., New York, N. Y., will be a useful activity in furthering fire prevention.

At the present time, a danger to industrial plants, especially those engaged in government work, arises from the presence of aliens whose sympathy is with our enemies, or renegade citizens who are traitors to the land of their birth or adoption. Foreign birth is, of course, no sign of enemy tendency. But a man or woman who gives any indication of pro-enemy sympathy

is to be regarded with suspicion, for "he who is not for us is against us" in these times.

One enemy alien with a will to destroy may be a menace to the jobs and the safety of hundreds of loyal employes in a plant. Hence, any suspicious actions or language should be at once reported to those in position to make it impossible for the suspect to do harm. Wrong opinions may be due to ignorance, and it is laudable to reform such opinions by teaching the facts about the war and the reasons why we are in it; but this is no time to take chances on the damage that may be done by either an enemy agent or a mistaken fanatic. Safeguard lives and property first; reform the individual afterward, should be the course of action.

Whether the activities enumerated are a stated part of the engineer's duty or not, they are his patriotic duty as a good citizen; his knowledge of the plant, and of technical matters, and his contact with workmen from all departments give him special opportunity and lay on him special obligation to be watchful and alert and to use every influence possible to prevent accidents and disasters.

The Isolated Plant—an Essential

Various prejudiced interests working throughout the country would lead the average layman to believe that, in order to realize the highest degree of efficiency and, incidentally, to bring about a maximum saving of fuel, it would be necessary to eliminate the isolated plant and in its stead, regardless of local conditions, employ central station service exclusively. Happily, however, the majority of persons are not so easily led to reach conclusions which, if allowed to govern their policies, might frequently tend to work to the detriment of all concerned. We speak of the substitution of central station service for the isolated plant, and vice versa, without due consideration of the entire situation.

That the central station can frequently provide service more economically than can the isolated plant is without question; but on the other hand, it is known and has been proved time and again that, in the case of many installations, and especially where heating systems are involved, the isolated plant enjoys a field which cannot legitimately be invaded by the central station. Only an investigation by engineers free from bias and influence can bring forth the facts necessary to determine which, in any particular case, should be adopted. Frequently, as in the case of the Burroughs Adding Machine Co., it may be found desirable to dispense with a private plant so long as the power and heating requirements are comparatively negligible, but with increasing demands, conditions are bound to favor isolated plant service, and if steps are not taken to provide this, increasing losses must be sustained.

For many years the Burroughs Company believed, and perhaps rightfully so, that it was operating as economically as possible; but after a thorough investigation had been conducted, the utter folly of continuing such a procedure became apparent and, as a result, no time was lost in rectifying the matter. By the investment of $230,000 for a completely equipped isolated power and heating plant, this company is now not only capable of realizing an annual return of over 40 per cent, but is also insured continuous service.

Some Work of the Ordnance Department

VERY FEW citizens have any conception of the various ramifications of the work of the Ordnance Department, U. S. A., the idea generally prevalent being that it has something to do with guns and ammunition.

As a matter of fact, the Ordnance Department comes in contact and deals with practically every industry in the country and is daily placing orders with firms all over the United States for materials needed for the successful prosecution of the war. These orders cover a wide range and are placed in quantities that are frequently staggering to the average mind. Commodities formerly ordered in hundreds are now ordered in millions; those formerly bought by ounces, are now ordered by the ton. A detailed list of the orders placed even for a short period would occupy too much space; but it may be of interest to those connected with the Machines and Metals trades to learn of some of the items, orders for which are placed by the Ordnance Department with these most important industries:

Compressed gas reservoirs, open hearth steel, steel bars, pig tin, sheet brass and copper, steel wheels, miscellaneous light and heavy towers with anchors and templates, alloy, sheet steel, 1½-in. manganese, soft aluminum wire for manufacturing meat cans, copper tanks, gratings, angle iron, frames, needle and globe valves, wire, cutter and stapling machines, aluminum sheets and rivets, copper clad wire rope, screw stock, soft steel wire, brass discs, soft sheet steel, block tin, open hearth sheet steel, ingot and sheet aluminum, ingots of german silver, hot rolled low carbon open hearth steel, Lake Superior copper, 62½-ton six-wheel switching locomotives, 38-ton 4-wheel saddle tank locomotives, 40-ton 4-wheel saddle tank locomotives, parts for locomotives, clam shell buckets, locomotive cranes, gravity conveyors, 2-wheel dock trucks, 40-ton flat cars, 20-gal. chemical engines, 40-gal. safety fire bucket tanks, storage battery trucks, with adjustable and stationary crane hoists, sewing machines, bench skiving machines and electric drills.

IT IS TIME for each individual to search his heart and to purge his mind and purpose of selfish motives and for each class in society to think in terms of its own interest. It is no time for any class to hug to its bosom the delusion that it possesses a monopoly of patriotism. Human nature is pretty evenly divided, and no little selfishness manifests itself in every direction.

There can be no slacking. If the free, democratic, law-abiding nations like Great Britain, Belgium and France are destroyed, if Prussian militarism is permitted to dominate, then the Anglo-Saxon fight for free institutions and liberty, persisting from Runnymede to Yorktown, its fight against the absolute right of kings and barons, with its Magna Charta, its Bill of Rights, its Declaration of Independence, and the heroic fight of the French, of the Italians of the Belgians and of other free peoples for liberty will have been made in vain.—DAVID HOUSTON.

Soot and Boiler Efficiency

SOOT REMOVAL AN EFFECTIVE MEANS TOWARD FUEL ECONOMY. BY ROBERT JUNE

OF ALL sources of preventable waste, formation of soot on the fire surfaces of the boiler is the most troublesome. Air leaks in the setting may be found and hermetically sealed. Losses due to radiation made be largely eliminated by proper insulation of the pipes, and losses caused by excess air drawn through the grates may be done away with in a large degree by the installation of stokers and draft gages. Scale may be removed by cleaning at regular intervals. It is a job usually requiring time and patience, but the periods of cleaning are comparatively far apart. Formation of soot, however, cannot be permanently stopped. It is an ever present source of trouble. Its deposit on the fire surfaces of the boiler is a continuous process.

FIG. 1. SLAG FORMATION IN FIRST PASS OF VERTICAL WATER TUBE BOILER DUE TO NEGLECT OF CLEANING

Soot is all but the best insulator known. In non-conducting properties it has proven to be more than five times as effective as fine asbestos. More heat would be transmitted to boiler tubes through a full 1-in. wrapping of asbestos than through 1/5-in. coating of soot. The table below is from Kent's Mechanical Engineer's Pocket Book.

WATER HEATED THROUGH VARIOUS SUBSTANCES

Thickness of each substance.....1 inch
Temperature applied to each.....310 deg. F.
Temperature increase of water in each case....10 deg. F.

	Substance	No. pounds of water heated.
1.	Loose wool	8.1
2.	Loose lampblack (soot)	9.8
3.	Hair felt	10.3
4.	Carded cotton wool	10.4
5.	Fine asbestos	49.0

A perfectly clean boiler tube, 1/8 in. thick, will transmit forty times as much heat as will a tube covered with 1 in. thickness of soot.

The loss in heat conductivity of boiler plate, due to soot deposit, may be noted in the following table:

Thickness of soot	Per cent of loss
Clean pipe	0.0
1/32 in.	9.5
1/16 in.	26.2
1/8 in.	45.3
3/16 in.	69.0

Fortunately soot does not collect on all surfaces of a boiler in the same proportion. Some portions may be fairly clean, while others are thickly coated. This does not lessen the fact that there is a wasteful expenditure of fuel and heat whenever a portion of the tubes are soot coated.

WHAT SOOT IS

THE PRINCIPAL constituent of "pure soot," or lampblack, is carbon. Mixed and associated with this carbon are various tar products and acids.

Soot found in steam boilers varies considerably in appearance and composition, depending upon the grade of coal burned, conditions of combustion, and the part of the furnace from which the sample is taken. Nearest the fire the deposits formed consist largely of ash. Analysis of samples of soot taken from the first pass of a boiler shows in addition to the pure soot the presence of silica, alumina, iron oxide, various alkalis and sulphur dioxide.

In color soot varies from black to gray, grayish white, grayish green, grayish blue, brown and reddish brown.

In all but the coolest portion of the setting soot is usually gritty in texture. The grains may be as large as medium sand, or as fine as cigar ash. These particles are in a plastic state when they leave the furnace, and striking the lower portion of the boiler, they adhere to the tubes.

If this deposit is not removed frequently it quickly increases in amount and changes in character. The carbon burns out in part and the mass cements together. The repeated reduction in heat-absorbing surface increases the temperature of the flue gases, so that the process of cementation is continuous and constantly increasing in intensity. An extremely hard, clinker-like formation results. In a short time the space between the tubes in some portions of the boiler is completely blocked, thus materially reducing its capacity. In this condition mining operations alone will remove the deposits.

A bad feature of these deposits is that, if they are

allowed to remain, the corrosive action of the various constituents of the soot is likely to cause leaky tubes. Under the influence of heat a ferrous carbonate is formed; the excess of air that is always present brings free oxygen in contact with the ferrous carbonate, and the reaction produces ferric oxide and carbonic acid. Carbonic acid, particularly in the presence of free oxygen, acts very rapidly on the metal of the boiler. Another source of corrosion is the sulphur dioxide in the soot, which changes first to sulphurous acid and then to sulphuric.

Only the boiler insurance companies know how many boilers are condemned annually as unfit for operation, years before their natural period for service would terminate. That the number is high we know, for cases are constantly coming to light.

Says the author of "Furnace Efficiency":

"I was talking one time with the manager of a very modern power plant in the very modern city of Minneapolis. We got around to the subject of soot, and the engineer said: 'I will show you that we keep our boiler tubes clean.' He raised the slide from one of the blow holes at the first pass in the boiler. There was a good light from the furnace just below the tubes and we had a fair view of them. They were reasonably clean. We then went to the back pass of the boiler, but there was no light from the furnace there and we could see nothing. While the engineer was in search of a light I found a piece of gas pipe about 6 ft. in length, thrust this through one of the blow holes in the last pass and across the tubes of the boiler. I could tell by the feeling of the pipe that there was a surprise in store for my engineer friend. The flashlight showed furrows an inch deep where I had plowed with the gas pipe across the top of the tubes.

"Now it is evident that the man who had charge of cleaning these tubes had not finished the job. He had blown soot from the first pass back into the second, and a double dose of soot from there back into the third. Then he had stopped. Now, if things like that can happen in a well-regulated plant, what can we expect to find in plants that are not regulated?"

To clean off soot properly, all of it should be blown off the tubes. To blow it from one locality to another does not help much. It is no uncommon thing to find soot so thickly packed into the corners, along the side walls of a water-tube boiler that you could use a hoe and shovel in removing it.

You want your boiler tubes to conduct heat as rapidly as possible to the water within the tubes. If you want to keep up steam when the soot piles up, you will have to pile in more coal.

Five Essentials in Preventing Soot Waste

(1) Frequency of cleaning in order to minimize the cumulative effects of increasing deposits. Tubes should be cleaned three to six times a day.

(2) Thoroughness of cleaning, in order to maintain high furnace and boiler efficiency and prevent destructive corrosive effects of soot accumulation.

(3) Availability of system; the soot-cleaner system capable of rapid operation.

(4) Durability of system; blower units should be so designed and constructed that they will withstand the stress of hard service when placed in the hottest portions of the boiler without necessity for frequent repair or replacement.

(5) Economy of operation; the soot removing system should require less steam and labor than hand blowing; it should be so installed as to prevent the entrance of cold air into the furnace during its operation; should be instantly available, automatic in action, it should pay for itself from an investment standpoint.

The modern mechanical soot blower of the best design fulfills all these requirements. That it is a paying investment is well illustrated by many detailed tests, of which a report by J. A. Moyer, published in December, 1914, issue, showed a gain of 0.66 lb. of water in the actual evaporation per pound of coal by using a mechanical blower over hand cleaning. Tubes were blown with the blower every 3 hr. Clearfield coal with heat value of 13,650 B.t.u. per lb. was used, the saving in coal by using the blower being 4.7 per cent.

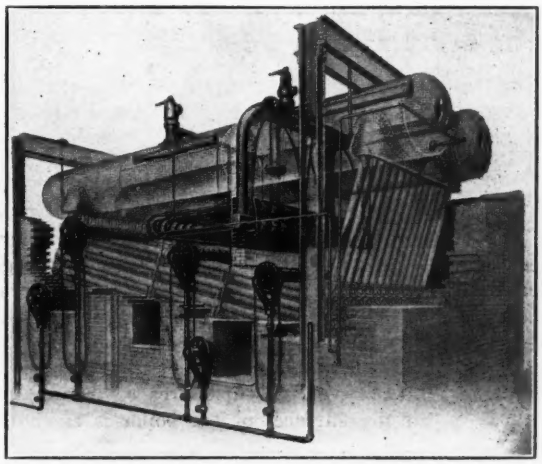


FIG. 2. HORIZONTAL WATER-TUBE BOILER EQUIPPED WITH DIAMOND MECHANICAL SOOT BLOWER SYSTEM

Conservation of fuel and labor is now a national necessity, consequently any means of reducing operating expenses and making savings by such methods as effective soot removal, should be adopted in every plant.

Small Geared Turbines

TO DRIVE small electric lighting outfits, exciter units for large alternators, or for direct mechanical drive, a line of steam turbines constructed along the same lines which give durability, ease of adjustment, and high economy to the larger turbine units, has been developed by the Westinghouse Electric & Manufacturing Co. and is now being manufactured in sizes from 15 to 50 kw. for direct-current service; from 30 to 50 kw. for alternating-current service, and from 30 to 100 hp. for mechanical drive.

This machine is a geared unit, very compact, and of rugged construction, as shown in the view of the direct-current unit, Fig. 1. The turbine operates at a speed of 7200 r.p.m., and it is suitable for both condensing and noncondensing operation. It is built for normal operation on any steam pressure from 75 lb. to 250 lb. for noncondensing operation on any back pressure up to 20 lb. It embodies the three-point sus-

pension principle, being supported by two lugs on the generator and one under the center of the turbine, thus maintaining perfect alinement of the turbine, gear and generator.

The generator is of the Westinghouse "SK" type, compound wound, with commutating poles. This design insures sparkless commutation even at heavy overloads, without shifting the brushes—an important advantage since no attention is required to adjust for changing loads.

The internal construction of the turbine is practically identical with that of the larger machines. It

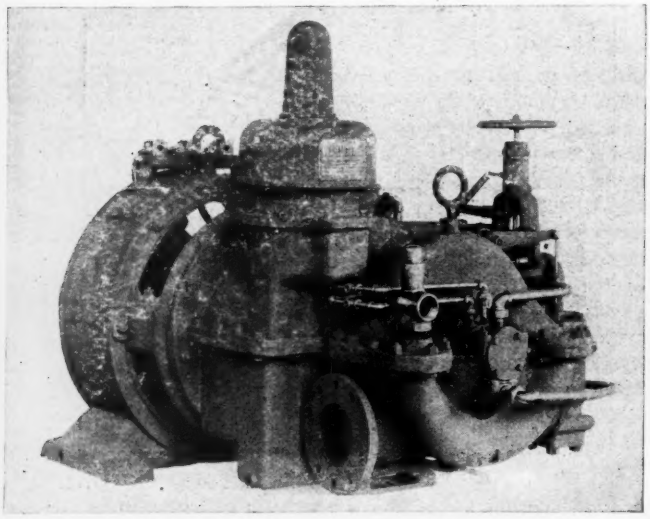


FIG. 1. EXTERIOR OF 25 KW. TURBO GENERATOR SET

consists of a single rotating wheel with blades or buckets around its periphery; the steam from the directing vanes or nozzles impinging against these blades causes the wheel to rotate and the work to be performed. The full energy of the steam is extracted by using only one wheel with the aid of what is commonly known as the re-entry principle; that is, the steam after passing through the blades the first time, is changed in direction by means of a reversing chamber and is directed against the blades a second time.

Bearings on the turbine end of this machine are cast iron, lined with babbit. Those on the rotor and pinion shaft are of the adjustable type, thus making it possible to keep a perfect alinement between pinion and gear at all times. The outboard generator bearing is a steel shell, lined with babbit, pressed into the housing and pinned in place. It is ring-oiled. The pinion is milled out of the solid rotor shaft, thus entirely eliminating the coupling previously used to connect the pinion and rotor shafts.

These machines are fitted with standard water-sealed glands of brass, shrunk on the shaft. These glands seal the turbine casing around the shaft and prevent steam from escaping when operating noncondensing, or they prevent air from entering when operating condensing.

The governor on this unit is of the low-speed vertical fly-ball type, identical in construction with the governors on the larger units. This slow speed is obtained by driving the governor with a pinion on the slow-speed gear shaft. The fly-balls are pivoted on knife edges, and they are very sensitive to even slight speed variations in the turbine.

At the base of the governor, and driven by the governor spindle, is a gear oil pump which furnishes the oil for both turbine and gear. The bottom of the gear housing is used as an oil reservoir, the pump lifting the oil from this reservoir to the top of the gear case, from where it flows by gravity through the oil strainer and to the bearings and other parts needing lubrication. The oil is kept cool by a copper cooling coil in the bottom of the oil reservoir and through which cold water is kept continuously circulating.

One of the special features on this unit is the automatic throttle valve, operated directly from the governor by means of a connecting rod. This valve is of the balanced type and very sensitive in operation, thus insuring a close speed regulation.

One of the latest refinements provided on very few small turbines is the overspeed governor release. This is a simple device contained in a small hole drilled in the shaft between pinion and rotor, and it consists of a cylindrical weight held in place by a coil spring surrounding it. In case the turbine should speed up to 10 per cent above normal speed, the weight due to centrifugal force overcomes the spring tension and protrudes a short distance from its normal position. By so doing it comes in contact with a lug, which, in turn, is fastened to a lever, the movement of which trips the throttle valve catch and allows the valve to be closed by a heavy coil spring.

This line of turbo-generators conforms to the Navy Department's specifications for ship service, being pro-

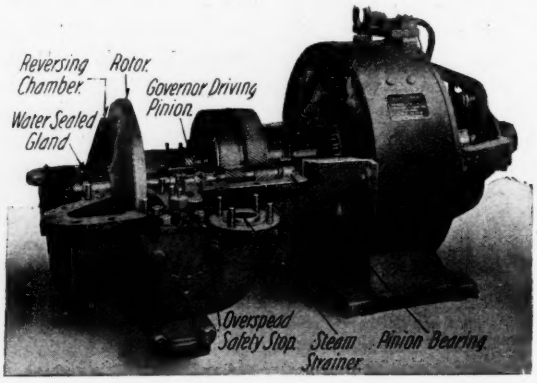


FIG. 2. GENERATING SET WITH TURBINE COVER REMOVED

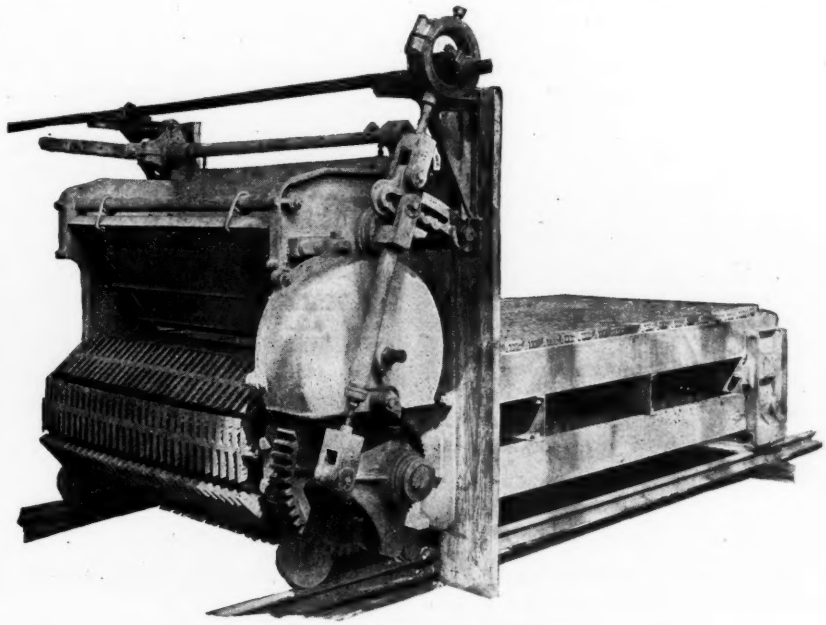
vided in this case with both steam and water-sealed glands, and noncorrosive brass piping.

POTATOES form 12.5 per cent of the food of American families, while in Europe they form 25 per cent, and for families of workingmen, 50 per cent. Investigation has shown that the Irish potato with oleomargerine gives almost a perfect nitrogenous food. We can raise unlimited quantities of this food, but the American nation must learn to use it, as a vegetable, as flour and as dried flakes, so that the supply may be utilized and conserved, the market increased and planting of large areas insured.

Brady Traveling Grate Stoker

WORKING upon principles that have been found successful in boiler furnace practice, Joseph Harrington, the engineer of the Jas. A. Brady Foundry Co., Chicago, Ill., has developed an entirely new design of traveling grate stoker intended for burning anthracite as well as all grades of bituminous coals. Essentially the grate consists of interlocking bars carried by cross T bars attached to three specially designed chains, in the links of which are grooved wheels that run on V tracks under the grate surface, while rollers at the sides of the links run on Z bars which support the weight of the grate during the return travel.

The provision of tracks gives a perfectly level surface the full length and width of the grate, and insures an undisturbed fuel bed.



THE BRADY TRAVELING GRATE STOKER

Each section of the grate is made up of a number of bars which are assembled on T bars extending across the furnace. The grate bars are held from sliding off the T bars by cotter pins, and new bars are easily put on as the section turns over at the end of the grate. Worn-out bars may be removed by hitting them with a hammer, which breaks the cleat holding the grate bar to the T bar.

Each grate bar is a smooth casting, the projecting ends being slightly wedge shape; the center line offset at the center giving strength at the point where it is attached to the cross T bar. At the rear of the grate the bars separate from the adjoining section, the ends drawing down from the grate surface, thus keeping the ends from projecting into the hot fuel bed, and the action of pulling the sections apart breaks up all clinker formation that may have lodged in the air spaces of the grate.

The space between upper and lower runs of the grate is divided into three transverse air compartments open at the top and closed at the sides and bottom, but arranged with dampers for admission of air and removal of such fine ash as falls through the grate. By this arrangement, air may be admitted in varying quantities at different sections of the grate, giving means for controlling the fire when either natural or forced draft is employed.

The grate is driven by an eccentric rod from a line shaft. This rod is made up of two, one telescoping within the other, and a strong compression spring is provided to prevent the breakage of any of the driving mechanism if for any reason the grate becomes blocked and fails to travel. Lost motion of more than one-third of a tooth is prevented by the provision of three pawls, and the reduction gearing is all inclosed to prevent coal dust from grinding into the gear teeth.

The fuel gate is lined with fire brick and provided with ventilating air spaces to prevent overheating of the iron parts of the gate and admit air over the fresh fuel. The grate may be used either with or without a waterback. These grates are being tried out in actual working conditions, and results of tests will soon be forthcoming.

Godfrey Coal and Ash Conveyor

IF acute fuel shortages such as experienced during the early part of this year are not to be repeated the coming winter, it will be necessary for the consumers of coal to provide themselves during the present summer months with quantities sufficient to tide them over periods during which deliveries cannot be made. This is especially true of all industries not engaged in the manufacture of commodities absolutely essential to the welfare of the nation.

And, while many owners and operators of not only power stations, manufacturing plants of all kinds, etc., but also coal yards, are eager to obtain their winter's

supply, the question of handling this coal has in the majority of cases presented a more or less perplexing aspect. In cases where large quantities of coal are to be stored, the labor cost will become almost prohibitive, and in the instance of the small plant, in which the matter of storage is considered as only an emergency measure, the installation of expensive coal handling machinery would not appear desirable. To meet these conditions, and that at a minimum of cost, the Godfrey coal conveyor has been developed.

For outdoor storage in close proximity to a railroad siding, the scheme shown in the accompanying illustration may be employed to advantage. The outfit employed consists essentially of a track pit with suitable chute, an overhead cable way, supporting structure, a bucket or buckets and the necessary source of power, which may be an electric motor or gasoline engine. Coal dumped from the cars is discharged by means of the chute into the bucket, which, when filled, is raised as shown along the cable way until the desired point of dumping is reached. This is accomplished automatically by a trigger at the bottom of the bucket coming in contact with piled coal and releasing the bottom of the bucket, which, due to the weight of the coal contained therein, is caused to swing to one side and thereby provide a free passage. With the weight removed, the bottom of the bucket, due to the acting of a heavy spring, is brought back into position and locked, ready for the next charge.

A TYPICAL GODFREY COAL CONVEYOR INSTALLATION

The length of the overhead cableway may be varied according to local conditions, and if so desired, tracks instead of steel aerial cables may be employed.

Ordinarily one man can control the entire operation of this outfit and can handle a maximum of 50 tons of coal per hour.

Advantageous features of this conveyor, which is manufactured by John F. Godfrey, Elkhart, Ind., are its simplicity, adaptability and primarily its ability to reduce coal-handling costs to a minimum.

R. Sanford Riley Called for Service

R. SANFORD RILEY, president of the Sanford Riley Stoker Co., Ltd., Worcester, Mass., and of the Murphy Iron Works, Detroit, Mich., has been requested by the Emergency Fleet Corporation to arrange for supervision of trial trips of all merchant ships now being turned out in this country. He undertook the organization of this department for the Emergency Fleet Corporation beginning July 1, but has an arrangement by which he will retain supervision of his other interests during his connection with the Emergency Fleet.

Before going into the stoker business, Mr. Riley had an extensive experience in marine engineering and shipbuilding. Mr. Riley's qualifications were mentioned to Chas. M. Schwab by former shipbuilding associates and this has resulted in his call to service.

Power Plant Efficiency Inspection

THE United States Fuel Administration announced recently the appointment of Henderson W. Knott to manage the field force of engineers and inspectors which is at work among the power plants of the country, carrying out a campaign of instruction and inspection designed to bring the use of fuel for the production of power to the highest possible efficiency and economy.

Mr. Knott has been the general manager of the Morgan Crucible Company of New York City.

The appointment of Mr. Knott is a part of the plan, originated by David Moffat Myers, advisory fuel engineer of the Fuel Administration, to have each of the 250,000 steam plants in the United States visited by a competent man who can make suggestions and report in connection with the questionnaire originated by Mr. Myers, working with committees from the four great engineering societies. This work will naturally require a large number of inspectors devoting their time to traveling among the steam plants.

This field force will be organized by states in order to give it greater force and efficiency. Many of the state heads who work directly under the State Fuel Administrators have already been appointed and Mr. Knott, co-operating with Mr. Myers, will complete the list of state appointees. Mr. Knott will, at an early date, visit the states already organized to study the work being done by the men in the field, and to speed up the inspection program.

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

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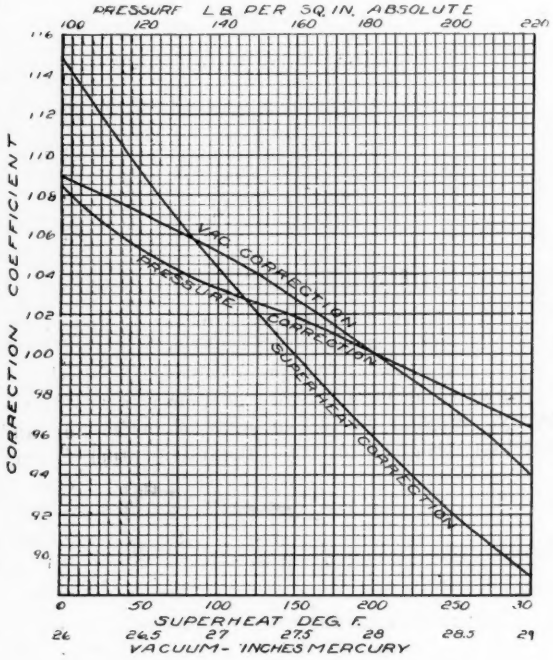
HENEY SAFETY BOILER CO.

POWER PLANT ENGINEERING

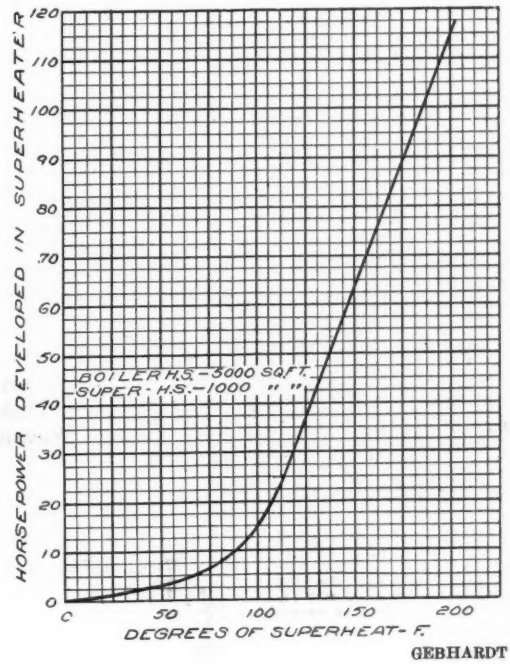
SUPERHEATER, PRESSURE AND VACUUM CORRECTIONS FOR HIGH-PRESSURE TURBINES


PRESSURE LB. PER SQ. IN. ABSOLUTE
100 120 140 160 180 200 220
CORRECTION COEFFICIENT
VAC. CORRECTION
PRESSURE CORRECTION
SUPERHEAT CORRECTION
0 50 100 150 200 250 300
SUPERHEAT DEG. F.
26 26.5 27 27.5 28 28.5 29
VACUUM- INCHES MERCURY

STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS

POWER PLANT ENGINEERING

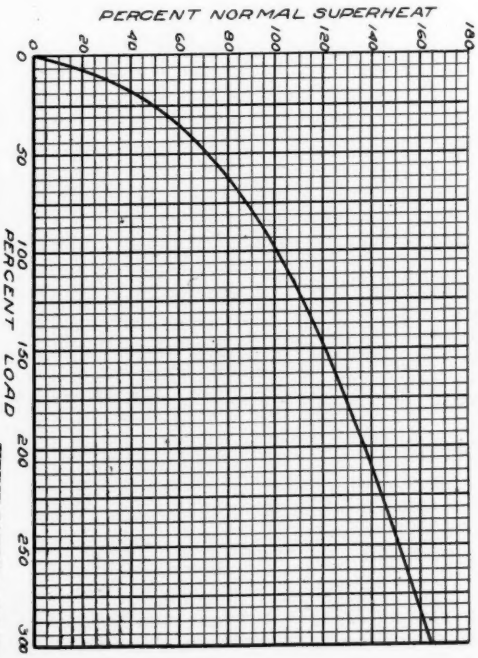
RELATION OF DEGREE OF SUPERHEAT TO HORSEPOWER OF SUPERHEATER


HORSEPOWER DEVELOPED IN SUPERHEATER
BOILER H.S.-3000 SQ.FT.
SUPER-H.S.-1000 " "
0 10 20 30 40 50 60 70 80 90 100 110 120
0 50 100 150 200
DEGREES OF SUPERHEAT-F.

GEBHARDT

POWER PLANT ENGINEERING

EFFECT OF LOAD ON SUPERHEATER WITH SUPERHEATER IN PATH OF BOILER GASES



THE VALVE WORLD

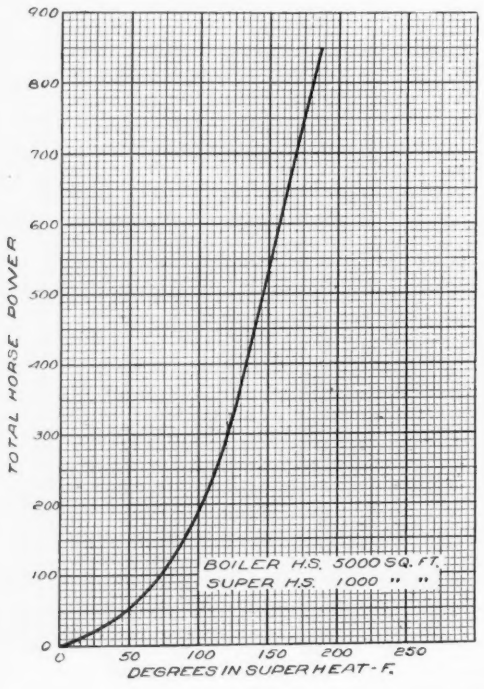
POWER PLANT ENGINEERING

RELIEVING CAPACITIES OF POP SAFETY VALVES

Size		Boiler Pressures				
		50 Pounds	100 Pounds	150 Pounds	200 Pounds	250 Pounds
1 inch	A	710	1,260	1,800	2,345	2,900
	B	850	1,510	2,160	2,815	3,480
1¼ inch	A	886	1,570	2,250	2,930	3,620
	B	1,055	1,885	2,700	3,425	4,345
1½ inch	A	1,060	1,885	2,710	3,530	4,350
	B	1,270	2,260	3,250	4,235	5,220
2 inch	A	1,420	2,510	3,595	4,710	5,800
	B	1,705	3,010	4,305	5,650	6,850
2½ inch	A	1,770	3,145	4,510	5,885	7,255
	B	2,125	3,775	5,410	7,060	8,705
3 inch	A	2,130	3,775	5,420	8,065	8,700
	B	2,550	4,530	6,500	8,480	10,440
3½ inch	A	2,480	4,400	6,325	8,240	10,160
	B	2,975	5,280	7,590	9,885	12,190
4 inch	A	2,840	5,030	7,230	9,420	11,610
	B	3,405	6,000	8,630	11,300	13,930
4½ inch	A	3,190	5,660	8,130	10,595	13,060
	B	3,830	6,700	9,750	12,705	15,670

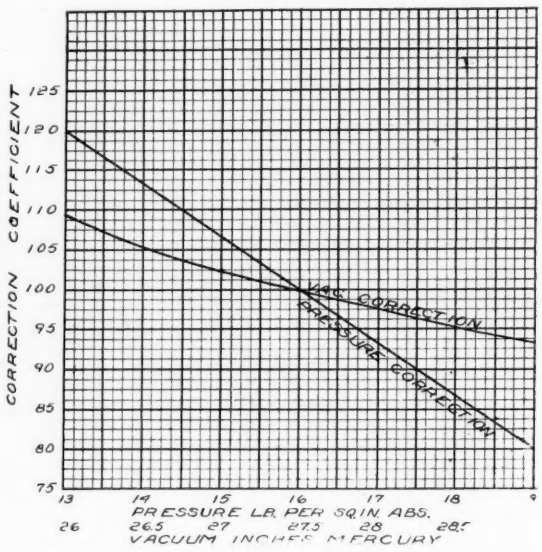
A Represents capacity at set pressure.
B Represents capacity at 3 per cent over pressure.

RELATION OF DEGREE OF SUPERHEAT TO TOTAL HORSE-POWER DEVELOPED



GEBHARDT

PRESSURE AND VACUUM CORRECTIONS FOR LOW-PRESSURE TURBINES



STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS

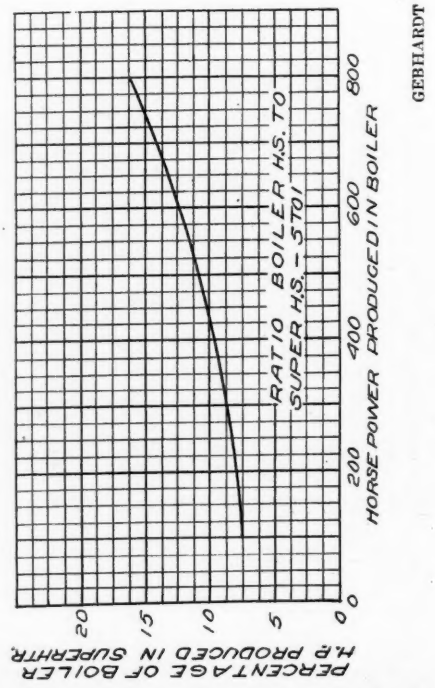
RELIEVING CAPACITIES OF RELIEF VALVES

Sizes ¾ to 2 inches — Brass. 2½ inches to 4½ inches — Iron Body.

Size	Set Pressures							
	25 Pounds	50 Pounds	75 Pounds	100 Pounds	125 Pounds	150 Pounds	175 Pounds	200 Pounds
¾ inch	3.8	5.2	6.5	7.5	8.5	9.5	11	13
1 inch	5	7.5	9.5	11	13	15	18	21
1¼ inch	7	9.5	13	15	17	20	23	27
1½ inch	9	13	16	18	21	25	29	34
2 inch	13	17	21	25	30	35	40	48
2½ inch	50	68	86	100	116	140	160	195
3 inch	60	80	100	122	142	170	195	240
3½ inch	70	95	120	145	170	200	230	280
4 inch	80	100	135	165	195	225	265	320
4½ inch	95	125	155	185	220	255	295	360

THE VALVE WORLD

RATIO OF HORSEPOWER PRODUCED IN SUPERHEATER TO THAT DEVELOPED IN THE BOILER



GEBHARDT

News Notes

ELLIOTT Co. announces the removal of its Philadelphia offices from 702 Franklin Bank Bldg. to 413 Pennsylvania Bldg.

W. H. CALLAN, general manager plants, and W. P. Pressinger, general manager sales, have been elected vice-presidents of the Chicago Pneumatic Tool Co., Chicago.

JOHN A. KERLEY, Past National President of the N. A. S. E., and for 21 yr. Chief Engineer and General Manager of the City Ice Delivery Co., of Cincinnati, has become associated with the Dearborn Chemical Co., and will be located at the Cincinnati office, covering a portion of the state of Ohio.

A. NIEDERMEYER, for many years connected with the Worthington Pump and Machinery Corporation, most recently as Works Manager of the Snow-Holly Works of that Corporation, at Buffalo, N. Y., resigned on May 31, to devote his entire time to enterprises of his own.

L. C. SPRAGUE has been appointed special representative of the Chicago Pneumatic Tool Co. in connection with the sale of pneumatic tools to railroads. Mr. Sprague was formerly connected with the Tool Co., but more recently has been connected with the railroad department of the H. W. Johns-Manville Co., New York City.

P. B. FINDLEY, technical editor in the Department of Publicity, Westinghouse Electric & Mfg. Co., has resigned from that position to enter the Training School at the University of Pittsburgh, where he will take a special course in radio work with the Signal Corps. Before going to the Westinghouse Electric Co. Mr. Findley was editor of the Electrical Age, in which position he made a large number of friends in the electrical field who will wish him success in his military work.

GEORGE H. CROSSAN, formerly of the purchasing department of the General Electric Co., at Lynn, Mass., is now acting in the capacity of Director of Purchases for the General Vehicle Co., Aeronautical Corp., and the Wright Martin Aircraft Corp., of Long Island City, N. Y.

THE MUNICIPAL Civil Service Commission of New York City has announced two examinations, namely, Inspector of Gas, Grade 2, and Stationary Engineer (Electric Pumping Station). Applications will be received at Room 1400, Municipal Building, Manhattan, until July 9 and 12, at 4 p. m.

Applicants must be at least 21 yr. of age, citizens of the United States and residents of the State of New York.

Candidates for gas inspector should have had practical experience in the analysis and testing of gas, or should have completed at least a two years' course of instruction in chemistry in a college or technical school of recognized standing. The examination will consist of two subjects: Experience, 4; Technical, 6. Vacancies occur from time to time in the Department of Water Supply, Gas and Electricity. The position pays a salary of from $1200 to $1800.

Stationary Engineers (Electric Pumping Station) are required to operate and maintain the high-pressure pumping stations for fire service. Candidates must have 5 yr. experience in connection with the installation or operation of electrical power plants as machinist, dynamo tender, engineer or in similar capacity; two years of this time must be in the actual handling of high tension apparatus. They must be familiar with centrifugal pumps, transformers, high tension switchboard apparatus, motor operated valves and other equipment in connection with the fire service station. The examination will consist of two subjects: Technical, 6; Experience, 4. Vacancies occur from time to time in the Department of Water Supply, Gas and Electricity; salary, $5 a day.

For further information apply to the Municipal Civil Service Commission, New York City.

Catalog Notes

A COMPLETE REPORT on the Australian customs tariff as it stands today has just been made public by the Bureau of Foreign and Domestic Commerce, Department of Commerce. The purpose of the report is to post American manufacturers and exporters on points in the new tariff that are not generally understood in this country. The preferential provisions, by which goods made in England and South Africa enjoy advantages over all others, are treated in great detail.

The bulletin is entitled, "Customs Tariff of Australia," Tariff Series No. 37, and is the work of Louis Domeratzky, tariff expert of the Bureau. Copies can be obtained at the nominal price of 10c from the Superintendent of Documents, Government Printing Office, Washington, D. C., or from any of the district cooperative offices of the Bureau of Foreign and Domestic Commerce.

HOW TO SAVE COAL is the title of Bulletin No. 41, issued by the Bailey Meter Co. This bulletin takes up discussions of Boiler Capacity, Boiler Efficiency, Combustion, Air Supply, Best Condition of Fuel Bed, Air as a Fuel, Evaporation Per Pound of Air, Measurement of Air and Steam, Effect of Coal, Temperature of Gases, Bailey Temperature Recorder, Draft and other topics which have to do with efficient boiler operation.

THE GENERAL ELECTRIC CO. has prepared for distribution Bulletin No. 48,024, entitled "Electricity in the Cane Sugar Industry," describing the advantages derived from the application of electrical apparatus in cane sugar mills and showing how the use of electricity has produced definite savings in the cost of labor, fuel, supplies and repairs. The savings given are based on authentic data and government cost figures.

This bulletin contains many interesting and instructive illustrations of G-E installations in Cuba, Porto Rico, Mexico and other cane-growing countries.

IN A PAMPHLET entitled Centrifugal Boiler Feed Pumps, the De Laval Steam Turbine Co., Trenton, N. J., describes the De Laval combined steam turbine and centrifugal boiler feed pump. In the machine here described the steam turbine rotor and the pump impellers are mounted upon one shaft, with only two bearings,

and are enclosed within one housing. The combined turbine pump casing is split horizontally, and by lifting the cover all internal and working parts are exposed. The steam and water connections are in the lower part of the casing and are thus not disturbed when the pump is opened. The turbine is of the velocity-stage type and the pump contains either two or three impellers, according to the boiler pressure. A pump for 3000 boiler hp. occupies a floor space of only 2 by 3 ft. The pamphlet also describes electric motor-driven units.

THE INGERSOLL-RAND CO., 11 Broadway, New York City, has recently issued the following new literature:

Form 4039—8-page bulletin on Leyner Shank and Bit Punch for punching out holes in bits and shanks of hollow drill steel.

Form 901—4-page flyer, showing the complete line of "Little David" pneumatic tools. Tables of sizes and capacities are given and illustrations show all the tools and their applications.

Form 9028—18-page catalog, illustrating and describing equipment for sugar factory and refinery service. A separate Spanish edition of this catalog is also available for those who desire it.

Form 901-1—single-page flyer on "Little David" calking machine.

Form 888—4-page flyer on "Little David" evaporator tube cleaning and other labor-saving pneumatic tools.

Form 876—single-page flyer on Ingersoll-Rand barometric condensing plants.

Form 883A—single-page flyer on Class "FP" steam engines, horizontal central crank type with piston valves.

Form 3015-1—4-page bulletin on "ER-1" portable mine car air compressors.

Copies of these publications will be mailed free on request to nearest branch office or agent.

AN INTERESTING folder from A. M. Byers & Co. of Pittsburgh, Pa., shows the longevity of wrought-iron pipe in resisting corrosion by a graphical system that is clear and convincing. Full report of the investigation is given in their Bulletin 30, which may be had on request.

SECTION 100 of the catalog of the Buffalo Forge Co., Buffalo, N. Y., describes portable forges with blowers, exhaust fans and other apparatus required for a complete smithy. It is a book of 112 pages, with full illustrations and price lists of various devices.

CATALOG NO. 3 of The Transmission Ball Bearing Co., of Buffalo, N. Y., describes the development of Chapman type ball bearings, installation, and application to car wheels, loose pulleys, swing frames and other purposes.

SCULLY STEEL & IRON CO., 2364 S. Ashland Ave., Chicago, offers a new booklet on Everlasting valves for blowoff service, superheated acid, acid mixtures, air, water and semi-fluids.

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